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POTATOES AND OTHER ROOT CROPS AS FOOD.

BY

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PREPARED UNDER THE SUPERVISION OF THE OFFICE OF EXPERIMENT STATIONS,
A. C. TRUE, Director.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., April 24, 1907.

Sir: In connection with the nutrition investigations of the Office of Experiment Stations, a number of studies have been made of the nutritive value and digestibility of potatoes and other root crops and the losses which such foods sustain when cooked in different ways. Many analyses of such foods have been made and other questions connected with their place in the diet and their most economical use in the home have received attention at several of the agricultural experiment stations.

The results of such investigations and the general information available in scientific journals and other works of reference have been summarized in the preparation of the present article on potatoes and other root crops used as food, by C. F. Langworthy, in charge of Nutrition Investigations of this Office, which I have the honor to transmit herewith and recommend for publication as a Farmers' Bulletin.

The article is similar in purpose to other popular summaries which have appeared in this series of bulletins. The section which concerns potatoes is a revision and extension of an article by Doctor Langworthy, published in the Yearbook of the Department for 1900.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

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POTATOES AND OTHER ROOT CROPS AS FOOD.

INTRODUCTION.

Among the products of the vegetable kingdom used for human food the cereals are undoubtedly the most important, but next to them must be placed the group of plants which during the favorable days of summer lay up for themselves a supply of reserve material in thickened roots or underground stems and bulbs. These plants belong to many different groups and have different habits and varied appearance, but from the standpoint of food value their common characteristic of producing underground parts filled with nutritious material makes it convenient and logical to group them together. In some cases it is a true root, such as the beet, in which the plant lays up its store; in others it is an underground stem as in the case of tubers like the potato, and again it is a bulb like the onion. Botanically, these distinctions are very important, but they have little bearing on the food value, and for the present purpose it is sufficiently accurate to speak of all such vegetables as "root crops."

These edible tuberous bulbs and roots divide themselves roughly into two main classes: Those in which the plant stores its food principally in the form of insoluble starch, and those in which a comparatively large proportion is in the form of sugar or some other soluble bodies. As a general rule vegetables of the latter group contain a larger proportion of water than the starchy tubers, etc., and are therefore often called the succulent roots.

Of the starchy group, the common potato is by far the most important as regards both its nutritive value and the extent of its cultivation. In the United States the sweet potato ranks next to it. What a prominent place these two together hold in the diet may be seen from the fact that in the average of 376 American dietary studies they were found to furnish 12.5 per cent, or about one-eighth of the total food material, and 8.3 per cent, or about one-twelfth of the carbohydrates. All other vegetables together furnished only 7.8 per cent of the total food and 3.7 per cent of the carbohydrates. There are no starchy tubers or roots except these in general use in this country, though a few are frequently seen in city markets. In other parts of the world, especially in eastern Asia and the Tropics, others to a large extent occupy the place which potatoes hold in Europe and America.

The succulent roots are less important as human food than the starchy ones. Beets, carrots, parsnips, turnips, and onions are the most common. Many of them are characterized by strong flavors and odors due to volatile oils which they contain. Like potatoes, they can be stored for months without serious deterioration, and being comparatively low-priced occupy an important place in the list of winter vegetables. Some highly flavored roots, such as the horseradish and ginger, serve mainly as condiments, their food value in the quantities in which they are used being too small to be of any practical importance.

The tubers and root vegetables may roughly be said to contain from 70 to 90 per cent water and from 10 to 30 per cent solid material. By far the greater part of the solid matter occurs in some form or forms of carbohydrates. There are also small quantities of nitrogenous substances, and, compared with most food materials, considerable quantities of mineral matters or ash, especially in the succulent roots. From this it will be seen that even the least watery of these vegetables is far from supplying the body with all that it needs. The carbohydrates furnish it with excellent fuel for keeping up its warmth and supplying it with energy needed for muscular activity. The ash and the various compounds which give flavor supply the needed mineral matters and stimulate the action of the digestive organs, but protein or nitrogenous material, which is indispensable in the building and repair of muscular tissue, is in most varieties nearly lacking, and in no case is it in the right proportion to nonnitrogenous material to serve for the best bodily development. Much is said about the Irish peasant and his potato diet and how well he can live and work on this fare, but in almost every case he keeps a cow along with his potato patch, and the abundance of milk in his diet furnishes him with a fair amount of protein. There is every reason to believe that among the tropical races, who are supposed to live mainly on the starchy roots and similar foods, there are some such sources of protein in the diet which general observers have overlooked. For instance, few travelers who write of the general use of rice in the Orient realize the importance of the nitrogenous soy-bean products so extensively used in China and Japan, or the milk, milk products, pulse, or legumes, and similar foods used in India. It is in connection with other materials richer in protein that the edible tubers and roots find their true place in the diet.

The potato so far surpasses all other tubers and roots in importance that its composition and nutritive value have been carefully studied both in this country and in Europe. It will, therefore, be discussed in detail and in a measure considered as a type of all the other tubers and roots, especially the starchy group.

7

POTATOES.

HISTORY AND EXTENT OF CULTIVATION.

The potato, called in different regions white potato, Irish potato, English potato, or round potato, was first introduced into Europe between 1580 and 1585 by the Spaniards, and afterwards by the English about the time of the expeditions sent by Raleigh to the Virginia country. It is believed to be a native of Chile, where a wild plant is still found which much resembles it. A similar tuber, known as the Cetewayo potato, is also eaten by the natives in some districts of South Africa. When first visited by Europeans, the aborigines in Chile and adjacent regions cultivated the potato for its edible tubers and had apparently long done so. It was probably introduced into the United States, especially into Virginia and North Carolina, toward the end of the sixteenth century. In spite of its easy cultivation, rich yield, and pleasant flavor, the potato did not receive a warm welcome when first introduced into Europe. For a long time there was a popular belief that it was poisonous, perhaps because botanically it is related to the deadly nightshade, and for years it was cultivated mainly as a garden curiosity. During the second half of the eighteenth century, however, came a series of bad harvests in some of the staple food crops throughout Europe and the potato quickly rose into almost universal prominence. Since then its use has constantly increased, for it is one of the cheapest vegetables to raise, can be kept over the winter, is easy to prepare for the table, pleasant in taste, and very rich in digestible starch. It soon became a staple food among all classes throughout central and northern Europe, so that when in the middle of the last century the black rot wrought its deadly havoc on the crops not only Ireland but large districts in continental Europe also were seriously threatened with famine. Next to the breadstuffs it is undoubtedly the most important food crop of the western nations.

According to the last United States census, 273,318,167 bushels were raised in this country in 1899, representing 40.7 per cent of the total vegetable crop, and valued at $98,380,110. Of course, part of the total crop is used for animal fodder and a part for various manufactured articles, but the proportion thus used is probably small, and includes mainly inferior grades of tubers. The principal article manufactured from potatoes is starch, which, until cornstarch supplanted it, was quite largely used in cooking, but now is mainly employed for making sizing for paper and textiles and for other technical purposes. Potato starch has also been sometimes found as an adulterant of fine flours and starches. Much of our commercial glucose is made from potatoes, and they are also an important source of alcohol, especially in Europe.

It is a fact worthy of mention that, as the potato has been modified by cultivation, it has largely lost the power of producing seeds, and the cultivated potato differs from the wild in seldom producing seed-bearing fruits. This is a disadvantage from the plant-breeder's standpoint, as he depends on seed from blossoms properly fertilized to yield new varieties. From the grower's standpoint it is of little moment, as he always uses the old tubers in planting the potato crop, each "eye" in the potato being a bud on the underground stem which is capable of growing into a new plant.

The potato is grown in practically all parts of the United States, but most abundantly in the North Atlantic and North Central States. Within recent years its culture has been greatly developed throughout the sandy pine tracts just south of the Canadian boundary, and local experiment stations have given great aid and encouragement to the work. The South Atlantic States furnish a considerable proportion of the crop, but mainly in the form of high-priced early potatoes for city markets.

STRUCTURE AND COMPOSITION.

The potato tuber, as has been said, is in reality a modified stem, being shortened and thickened as a storehouse for material held in reserve for the early growth of new plants. The outer skin of the tuber consists of a thin, grayish brown corky substance and corresponds roughly to the bark of an overground stem. If a crosswise section of a raw potato is held up to the light three distinct parts besides the skin may be seen. The outermost one is known as the cortical layer and may be from 0.12 to 0.5 inch in thickness. This layer is slightly colored, the tint varying with the kind, and turns green if exposed to the light for some time, thus showing its relation to the tender green layer beneath the bark of overground stems. It is denser than the other parts of the potato and contains many fibrovascular bundles, especially on the inner edge where a marked ring of them plainly separates this layer from the next. The interior or flesh of the tuber is made up of two layers known as the outer and inner medullary areas. The outer one forms the main bulk of a well-developed potato and contains the greater part of the food ingredients. The inner medullary area, sometimes called the core, appears in a cross section of the tuber to spread irregular arms up into the outer, so that its outline roughly suggests a star. It contains slightly more cellulose and less water and nutrients than the outer medullary portion. These four parts of the tuber are shown in figure 1.

As in all other plant forms, the framework of the tuber is made up of cellulose, a carbohydrate or group of carbohydrates familiar in many forms, as, for instance, the fiber of cotton or linen or the bran of wheat. In food and feeding stuff analyses it is usually designated crude fiber. Cellulose forms the walls of a network of cells, which in turn form the body of the tuber. These cells vary in shape and size in different sections of the tuber according to the part they play in its life. In the flesh they serve mainly for storage, and in them lie the starch grains. (See fig. 3*a*.)

The interior of the tuber is more or less permeated by water in which are dissolved nearly all the soluble ingredients, including the various soluble carbohydrates,[a] mineral matters, and soluble proteid bodies.

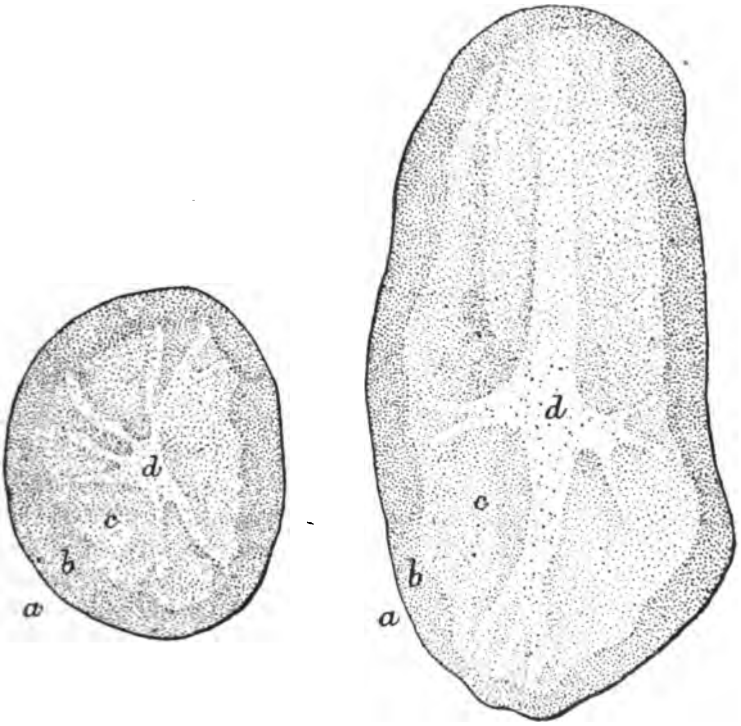

FIG. 1.—Transverse and longitudinal sections of the potato: *a*, skin; *b*, cortical layer; *c*, outer medullary layer; *d*, inner medullary area.

Cultural varieties of a given plant often have very different habits, appearance, and quality, and it is natural that the amounts and proportions of water, carbohydrates, fats, protein, and mineral matters which the potato contains should vary with the variety as well as with the character of the soil, the climate, and other conditions under which it grows. Moreover, since the needs of the potato plant vary at different stages of its developement, it will provide for them by varying the ingredients stored in the tubers and elsewhere. Taking into account all these factors, it might seem impossible to make any general statements about the chemical composition of the potato, but it may be said that the variations are in degree rather than in kind, and so many analyses and studies have been made, both in this country and in Europe, that the average or general characteristics of the potato are now well established. The figures in Table 1 show the composition of raw and cooked potatoes and represent the average of many American analyses. For comparison the composition of white bread is also given.

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[a] In this connection it is well to recall that the carbohydrates (cellulose, starch, the different kinds of sugars, etc.) are all closely related, and that under the influence of certain acids, heat, or other agency an insoluble form, such as starch, may be changed into a soluble form, or vice versa.

TABLE 1.—*Composition of raw and cooked potatoes.*

Kind of food.	Refuse.	Water.	Protein.	Fat.	Carbohydrates.		Ash.	Fuel value per pound.
					Sugar, starch, etc.	Crude fiber.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Potato, as purchased	20.0	62.6	1.8	0.1	13.8	0.9	0.8	310
Potato, edible portion		78.3	2.2	.1	18.0	.4	1.0	375
Potato, boiled		75.5	2.5	.1	20.3	.6	1.0	410
Potato, mashed and seasoned		75.1	2.6	3.0	17.8		1.5	505
Potatoes fried in fat, "Potato chips"		2.2	6.8	39.8	46.7		4.5	2,675
Potato, evaporated		7.1	8.5	.4	80.9		3.1	1,680
White bread		35.3	9.2	1.3	52.6	.5	1.1	1,215

The corky skin of the potato makes up about 2.5 per cent of the whole, and the cortical layer 8.5 per cent, leaving 89 per cent for the medullary areas. Theoretically, the skin is the only refuse or inedible material in the potato, but in practice a considerable part of the cortical layer is usually removed with it. When the surface is irregular or lumpy or the tubers have shriveled in storage, a much greater proportion of the flesh is likely to be cut off with the skin in peeling than is the case when the tubers are smooth and in good condition. When potatoes are baked or boiled in their jackets, more or less of the flesh is wasted when the skin is removed, and in this case also the amount bears some relation to the shape of the tubers. Just how much such a loss of edible portion averages it is hard to say. In connection with the nutrition investigations of this Department, it was estimated that in peeling raw potatoes the loss was about 20 per cent, which would include not only all of the skin and the cortical layer, but also 9 per cent from the flesh. When we recall how large is the proportion of water and how low that of nutrients in the tuber, and also that the larger proportion of the valuable protein and mineral matters is in the outer layers, this waste appears more important than is generally realized.

The edible portion of the potato, i. e., the tuber without the corky skin, holds on an average about 78 per cent water, and so only about

20 per cent of the whole tuber has a direct food value. Figure 2 represents the composition of the potato in graphic form and shows the proportion usually wasted when it is boiled.

This diagram shows very plainly that the bulk of the potato tuber is water. The stage of growth and other conditions affect the proportion present, young tubers being more juicy or watery than those which are fully developed. When potatoes are stored, they undergo a shrinkage chiefly owing to loss of water or juice by evaporation. According to tests made at the Michigan Agricultural Experiment Station this loss amounted to 11.5 per cent when they were kept in storage from September 30 to May 1.

The carbohydrates are by far the most abundant of the nutrients. Of the 18.4 per cent present less than 0.5 per cent is made up of cellulose, yet one sometimes hears the statement made that potatoes are indigestible on account of the large quantities of cellulose which they contain. In reality there is as much or more in almost all the cereals and other vegetable foods, and such a criticism of the potato has no warrant of fact.

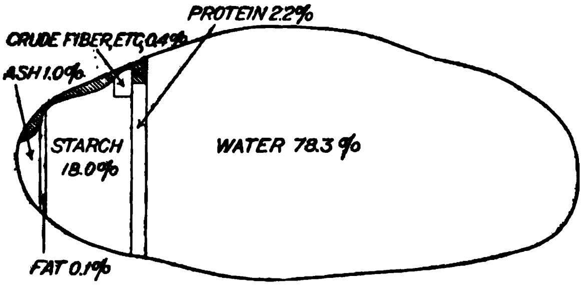

FIG. 2.—Composition of the potato. The shaded portion represents the average loss of nutrients when boiled.

The bulk of the carbohydrates which the potato stores for future use is in the form of starch, which is, of course, insoluble in cold water, and small quantities of such soluble carbohydrates as dextrose, sugar, etc. In young tubers there is a larger proportion of sugars and less starch than when they have become mature. As the tuber lies in the ground the starch content increases. When it begins to sprout, however, part of the starch is converted by a ferment in the tuber into soluble glucose. Thus, young or early potatoes and old ones both have a smaller proportion of starch and more soluble sugars than well-grown but still fresh tubers. If the grated potato is mixed with water starch falls out from the broken cells and settles to the bottom of the vessel, and may be removed in the form of a white deposit. Starch is manufactured to a large extent from potatoes by methods which are similar to the above in principle.[a]

Other carbohydrates in the potato are the so-called pectose bodies, the substances which cause fruit jellies to stiffen, and when the tubers are large and pulpy pectoses may make up 4 per cent of the tuber, though they usually occur in much smaller quantities. They are believed to have about the same food value as starch.

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[a] For an extended account of the manufacture of starch from potatoes, see U. S. Dept. Agr., Bur. Chem. Bul. 58.

Fat, or ether extract, appears in such small quantities in potatoes that it may be practically neglected in discussing their food value, especially as the greater part occurs in the inedible skin in the form of a wax-like body.

The protein bodies are rather scanty, as compared with those of cereals and such vegetables as peas and beans. Only about 60 per cent of the total amount present is true protein—that is, in a form which can be used for the building and repair of body tissue. This means that a pound of potatoes furnishes only about 1.3 per cent or 0.2 of an ounce of true protein, and emphasizes the statement already made that potatoes alone make a very incomplete diet, as the proportion of nitrogenous material would be very small in a quantity sufficient to supply the body with all the energy-yielding material required.

These potato proteids have been studied by the Connecticut Experiment Station and found to consist of a form of globulin, for which the name "tuberin" is suggested, and a proteose, part of these nitrogenous constituents being dissolved in the juice and part stored with the starch in the cells, especially in the cortical layer.

The nonproteid forms of nitrogenous substances in the potato are asparagin and small quantities of amido acids, occurring mostly in the juice. If they have any food value it is indirect and due to the fact that they protect the true proteids from waste during digestion. It is possible that they may aid digestion in some way or serve a similar purpose. There is a larger proportion of protein compounds, and especially of the more soluble forms, in young potatoes than in old.

The most important mineral matters found in potatoes are potash and phosphoric acid compounds. There are several organic acids (as citric, tartaric, and succinic acid), which vary in tubers of different ages and account in some measure for the flavor of potatoes. (See also p. 19.)

If peeled potatoes are exposed to the air the outer surface turns brown, just as does the flesh of many fruits. Such change is due to the action of enzyms or unorganized ferments naturally present in the plants. In the presence of the oxygen of the air they work upon tannin-like bodies in the tuber or fruit in such a way that the latter change color. In the case of potatoes this browning may be prevented by putting the peeled tubers into salted water or even into cold plain water.

In the condition in which they are purchased potatoes resemble such succulent carbohydrate foods as turnips and beets, with an average water content of 90 per cent, more than they do such dry carbohydrate foods as flour or rice, with an average of 12 per cent. The condition in which foods are eaten should also be taken into account, for if the value of a food is judged solely by its chemical composition as it is found in the market a wrong impression may be obtained. For instance, potatoes as purchased consist of one-fifth and rice of seven-eighths nutritive material. The first inference is that rice is more than four times as nutritious as potatoes. In one sense this is true—that is to say, a pound of uncooked rice contains more than four times as much nutritive material as a pound of raw potatoes. But if we take about 4 pounds of potatoes—that is, the amount necessary to furnish as much nutritive material as the pound of rice—the composition and nutritive value of the two quantities will be just about the same, while from a pecuniary standpoint the advantage would be on the side of the potatoes. The chief difference in the two foods before cooking is that one is juicy and bulky, while the other is dry, and therefore more concentrated. In cooking rice we mix water with it, and may thus make a material not very different in composition from potatoes. By drying potatoes they can be made very similar in composition and food value to rice. Considering the two articles as ordinarily purchased, 4.5 pounds of raw potatoes and a pound of uncooked rice contain nearly equal weights of each class of nutrients and have about the same nutritive value.

COOKING.

In cooking, the heat affects the various constituents of the potato in different ways. The water expands into steam, part of which evaporates from the surface. Within the minute cells making up the tuber it presses so hard against the walls that the tough cellulose is ruptured just as any air-tight vessel may be broken by the pressure of expanding steam. The starch grains inside the cells are thus released, some of them being also disintegrated, while part are changed into the soluble form of dextrin by the heat and part are filled with water or hydrated. The protein coagulates or hardens much as the white of egg does in boiling, and at least a part of it is broken down into simpler bodies. The mineral salts are probably little affected, but some of them are broken down, part of their constituents passing off as gases and part forming new compounds with quite different characteristics. It is the sum of these and minor changes which make the difference between a raw and a cooked potato. As may be seen from the figures in Table 1, the cooked potatoes which contain no added fat or other material do not differ much from the raw as regards composition. The effect of cooking on the mechanical condition of the potato cells is shown in figure 3.

The figures show the great changes in the mechanical condition of the potato flesh under the influence of heat, the broken cell walls and the increased bulk of the starch grains being particularly noticeable.

The mealy, soft, porous, cooked potato is in a favorable condition for the action of the digestive juices, as moisture readily penetrates to all parts of it, while this is not the case with the raw and rather tough flesh of the uncooked tuber. It is commonly said that raw starch, like that found in the potato, is not digestible, but later investigations indicate that this is not the case and that the digestive juices will dissolve the starch, provided the cell walls are ruptured so that the ferments may come in contact with it. The fact that some of the starch may be changed to soluble bodies under the influence of heat in cooking is an advantage rather than the reverse from the standpoint of digestion.

One of the great advantages in cooking potatoes and similar vegetable foods is the improvement in flavor. Raw potatoes, especially old ones, often have a decidedly bitter and disagreeable flavor (see p. 20), which is less marked after cooking, as some of the flavor-yielding bodies are volatilized or are extracted. The flavor of the cooked potato is also due in part to the development of the cooked-starch taste, which is much more pleasant than that of raw starch.

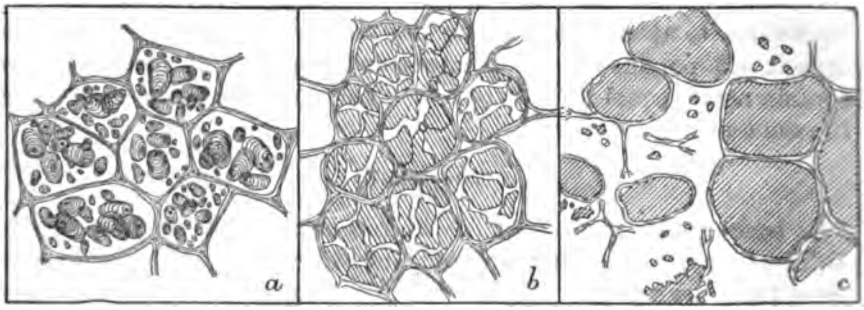

FIG. 3.—Changes of starch cells in cooking: *a*, cells of a raw potato with starch grains in natural condition; *b*, cells of a partially cooked potato; *c*, cells of a thoroughly boiled potato.

There are also disadvantages in the results of cooking, and though on the whole they are much less important than the advantages nevertheless they influence the food value. There is some reason for believing that the protein of the potato when stiffened by heat is less easily digested than when raw. A much more serious matter is that considerable quantities of the nutrients may be lost from the potato during cooking. So important is this point that at the Connecticut and Minnesota experiment stations several series of experiments have been made to determine just how much of the various nutrients is thus lost when the potatoes are cooked in various ways. In some of the tests distilled water and in others limewater and alkaline water were used, but the quality of the water seemed to have little influence on the loss. In other experiments some of the potatoes were soaked for several hours before boiling, and it was found that this tripled the proportion of protein lost and doubled that of the ash. If the potatoes were put into cold water at the start, it was found that they lost almost twice as much protein (15.8 per cent) as when they were plunged at once into boiling water (8.2 per cent). With the cold they lost 18.8 per cent of their ash and with the hot water practically the same amount. It has been suggested that the difference in the amount of protein removed is due to the fact that when the potato is plunged into boiling water the protein near the surface hardens at once and hinders the escape of juices from the interior. When, on the other hand, it is heated slowly much of the juice soaks out before the protein coagulates. On account of these losses in boiling potatoes many persons consider steaming preferable. (See p. 11.)

The tests just described were all made with peeled potatoes, but another series was made with unpeeled ones in which it was found that when boiled in their jackets potatoes lost only 1 per cent of their protein and a little over 3 per cent of their ash, no matter what the temperature of the water was at the start. Almost no starch is removed when potatoes are boiled in their skins, but when peeled the mechanical action of the boiling water wears off the outer surface and in this way as much as 3 per cent of the carbohydrates may be lost.

Evidently, then, by far the most economical way to boil potatoes is in their jackets. When they are cooked this way they should, of course, be thoroughly scraped before boiling and it is a common practice to remove a section of the skin at each end of the potato or to pare a ring around the middle of the tuber so that the moisture may escape and the cooked potato may not become soggy on standing. If they are peeled before cooking they should be placed directly in hot water.

When baked in their skins potatoes probably undergo much the same changes as in boiling, save that they lose practically none of their ingredients except a little water which evaporates through the skin. Some of their moisture changes to steam inside, and unless the potatoes are to be eaten immediately this must be allowed a way of escape through a break or holes made with a fork in the skin, or it will change back to water and make the potato soggy.

When raw potatoes are fried they should be cut into small pieces in order that the heat may penetrate to the interior before the coating of fat on the outside becomes scorched. They lose some water by evaporation and absorb considerable fat. The thinner the pieces the greater will be both these changes. Thus potato chips are found to contain only 2 per cent of water and 39.8 per cent of fat, whereas the raw tubers contain about 78 per cent water and 0.1 per cent fat.

When boiled potatoes are mashed with milk and butter, fried, or prepared in any of the multitudinous ways familiar to good cooks, their composition will be that of plain boiled potatoes plus the nutrients in the materials added. Purée of potatoes made with milk would make a much better single ration than plain potatoes, because it contains a higher proportion of protein. Salt, pepper, and other seasonings have also a decided value in that they improve the flavor of the potatoes and make them more appetizing. The potato may be prepared for the table in a great many ways, and this is an advantage, as it helps to give variety to the diet.

Grated potatoes are sometimes mixed with yeast and used in place of flour for making a kind of bread, rolls, or other similar food. Many cooks think that starting yeast for bread or rolls with potatoes instead of wheat flour makes a lighter sponge. This may be because the potatoes contain a more favorable proportion of the carbohydrates and other nutrients upon which the yeast feeds than does the wheat flour.

In this country the main test of the cooking quality of the potato is whether or not it yields a light, crystalline mass with almost distinct starch particles, or, in common parlance, its mealiness. Investigations were carried on at the Cornell Experiment Station to learn what it was that produced this mealiness, and the conclusion was reached that it depended mainly on the starch. If this was abundant and evenly distributed throughout the tuber the cells would burst open in cooking and make a light, flaky, uniform mass. If the starch was scanty in any part of the potato, water would be likely to settle there and make the cooked potato soggy. Mature but still fresh tubers hold more starch than either young or long stored ones as we have already seen, and the inner medullary layer is more likely to be poor in starch than the outer layer. Therefore the tubers most likely to cook into mealiness are the well-developed crisp ones. When the tubers are young or watery, or have a large core with many long arms branching into the outer medullary section, they are not so likely to be mealy when cooked.

This, however, does not tell the whole story. Anyone who cares for early spring potatoes knows that there is a quality between sogginess and mealiness which is very satisfactory and which is commonly described as waxiness. In many parts of Europe this condition is generally preferred and is considered a mark of excellence. While mealiness depends on starch and sogginess on water content, waxiness, according to the French authorities, Coudon and Boussard, depends on the proportion of protein to starch. If the protein is sufficiently abundant, it will as it hardens in cooking form a sort of waxy framework in which the starch will be lightly held together instead of separating into distinct flakes as in mealy potatoes, where there is not enough protein present to resist the pressure of the starch. Such waxy potatoes retain their shape better than the mealy ones and are more suitable for garnishing meats for salad making and for the preparation of many fancy dishes. As has been shown, the proportion of protein to starch is greater in young than in mature tubers, and therefore, in American potatoes at least, the early varieties are most likely to have this waxiness. In point of flavor there is almost as much difference as in consistency, as the nitrogenous tubers usually contain also a larger proportion of acids and perhaps sugars and solanin (see p. 19) than the starchy.

DRIED OR EVAPORATED POTATOES AND CANNED POTATOES.

Potatoes are so valuable in the diet that many attempts have been made to put them into a compact form in which they can be kept for a long time. This is usually accomplished by drying them, which both preserves them from decay and reduces their bulk. One of the oldest of such preparations is one long used in Peru and known as "chunno." To make it, part of the juice is pressed out of the potatoes, which are then dried in the air until they are reduced to about one-fourth of their original weight. There is a variety of similar preparations in American and European markets, and although the mode of procedure differs considerably in the various brands the main principle is the same, namely, to check bacterial action. The changes which we call decay are caused mainly by the development of bacteria. These can reproduce only where there is moisture and warmth present. Therefore, if the moisture is removed, their growth is retarded. The fact that the bulk of the potatoes is reduced at the same time is especially advantageous because such dried preparations are used mainly for camping expeditions, long sea voyages, and under other conditions where storage space is at a premium. The composition of such desiccated or evaporated potatoes is practically that of the original tubers minus more or less of the water. (See Table 1, p. 10.) Of course if extreme heat is used in the preparation, part of the starch may be changed to dextrin and there may be other minor changes in the chemical composition. There is no reason to suppose that these decrease the nutritive value. Various kinds of desiccated potatoes have been studied at the California Agricultural Experiment Station. Their water content ranged from 4.8 to 7.9 per cent, and their total carbohydrates from 77.9 to 80.6 per cent. In fact, their general composition was not unlike that of good white flour. They contained slightly less water, protein and fat, slightly more carbohydrates, and noticeably more mineral matters. Of course desiccated potatoes are supposed to be soaked in water before using and in this way regain somewhat their original characteristics. While their flavor and appearance can not equal those of good fresh potatoes, they are considered very appetizing and acceptable where fresh ones are unobtainable.

Chemical substances are sometimes used for improving the color (i. e., "bleaching") of desiccated potatoes. While a small quantity of these may be harmless, their continued presence in the diet might be very dangerous, and their use is not to be recommended.

Canned potatoes are on the market and are prepared for use in camps or wherever it is not convenient to cook food. They also may be kept in good condition for a long time. In composition such goods do not differ from similar freshly cooked potatoes.

STORAGE: ITS EFFECT ON QUALITY.

It is a fact of common experience that potatoes suffer more or less change during storage. If the tubers were originally diseased, the rot or other disease will go on developing until the potatoes are quite unfit for food, or if they have been bruised and are stored in a very warm, moist place, the injured portion offers an entrance to microorganisms and bacteria may develop in them and produce decay. But aside from these abnormal changes, there are others which occur under the best of conditions. Everyone knows how potatoes shrink and change their flavor as the winter grows late. The water tends to evaporate, and this is accompanied by certain chemical changes within the tuber. The potato, it must be remembered, is not a dead thing, but one in which active plant life is waiting to be renewed as soon as conditions are favorable. Even during the latent winter period the protoplasm of the cells is constantly producing minute changes in which part of the sugar is broken down and carbonic acid and water are given off. Part of the insoluble starch is also changed into dextrin and other soluble forms. This is believed to be due to the action of ferments normally present, which aid the plant by thus changing its stored food into a form in which the protoplasm can use it for new growth. The extent of these changes seems to depend on the age of the tuber and the temperature at which it is kept. The older it is the more ready it will be to begin its new growth and the more abundantly will the starch be converted into sugars. This explains why old potatoes are less starchy and mealy and sometimes sweeter than fresh ones. The temperature affects especially the activity of the protoplasm and the production of water and carbonic acid from the sugar, and thus it is that potatoes stored in a warm place are more likely to shrink than those in a cool place. These facts also suggest why frozen potatoes have such a sweet taste; the change of starch into sugar by the enzyms goes on regardless of the cold, but the activity of the cell protoplasm is checked by the cold and instead of being broken down the sugar accumulates. The sweet taste is more noticeable in tubers which have been slowly frozen than in those subjected to a sudden cold because the sugar has had a longer opportunity to form. If frozen potatoes are left for a few days in a moderate temperature, part of the sugar will revert to starch and the sweet taste in a measure disappear, but such potatoes never wholly regain their original flavor. Of course the amount of material which is broken down during storage will vary with the conditions, but sound potatoes properly stored should not shrink more than 10 or 12 per cent. The most favorable temperature for keeping potatoes is from 32 to 50° F., and if the storeroom is dry, well aired, and partly lighted, they are less likely to be attacked by disease or harmful bacteria.

Toward spring, or, if the tubers are old, even during the winter, potatoes begin to show signs of new growth, no matter how carefully they have been stored. Of course after the sprouting begins, the chemical changes take place very rapidly and the quality of the potatoes for food falls off decidedly. The reserve starch is drawn on by the growing shoots and with it goes the "mealiness."

POSSIBLE DANGERS FROM EATING POTATOES.

As has already been pointed out (p. 7), potatoes, when first introduced into Europe, were regarded as poisonous. This prejudice was soon overcome and the fact generally recognized that under ordinary circumstances potatoes are unquestionably wholesome food. Occasionally one hears of a person who is made ill by eating potatoes just as some are made ill by milk, by strawberries, or other food. Such cases are rare and due to individual idiosyncracy. Reference can not be made here to diabetes or other conditions of ill health in which potatoes and similar starchy foods are not permitted, since this is a subject which pertains to the practice of medicine rather than to a discussion of dietetics.

Cases of actual poisoning from potatoes are not unknown, and perhaps, without exception, have been found to be due to an abnormal solanin content such as is found in sprouted tubers, in very old potatoes, and in potatoes which have turned green on exposure to the light. Solanin is a characteristic constituent of potatoes and other plants of the same family. It is acrid in taste and is poisonous. Only a trace, however, about 0.01 per cent on an average, is found in the tubers of the varieties which are grown for the table, and this quantity is far too small to cause any unpleasant symptoms. It is claimed that the characteristic flavor of potatoes is due to this mere trace of solanin. At any rate, the very starchy potatoes which are lacking in flavor contain only about half as much solanin as the better table varieties. Potatoes which have grown on the surface of the ground or which have been exposed to the light frequently turn green, and such tubers contain abnormal amounts of solanin, as do old and shriveled potatoes which have sprouted. It is best not to use such old potatoes, but if they are eaten the flesh around the sprouts should be cut away, as this portion is particularly liable to contain solanin. Small or unripe tubers contain a higher percentage of solanin than full-grown tubers.

Analysis has shown that wild potatoes contain practically the same kind and proportion of nutrients as the cultivated varieties. The solanin content, however, is very considerably larger, 0.3 per cent having been found. These wild potatoes when cooked are slimy and almost translucent and entirely inedible.

MARKS OF GOOD POTATOES.

Appearance, taste, and consistency are the points by which we judge a cooked potato. Unfortunately it is not always easy to tell from their appearance which raw potatoes will prove the best, but there are certain marks which aid in making a choice.

The early varieties and young potatoes generally are preferable to more mature ones in point of flavor. Such tubers usually have a smoother skin than older ones. They are not as mealy, however, and do not keep as well. Late in the season, therefore, well developed tubers are safer. Very large ones are not especially desirable, partly because it is hard to cook them evenly and partly because they are often very variable in texture. Smooth, regularly shaped tubers with comparatively few eyes are more economical than irregular ones which can not be peeled without undue waste. In this country white or creamy-fleshed varieties are preferred, but in Europe yellow-fleshed varieties are most esteemed.

Different varieties may have distinct flavors, but the soil and climate in which they are grown and the fertilizers used cause such great variations that variety alone is no sure guide. Age is by far the most important point in determining flavor. The early varieties usually contain a larger proportion of mineral matters, acids, and protein, and therefore have a richer flavor, as has already been said. Tubers old enough to sprout begin to develop an acrid taste, due in part at least to an increased solanin content, which makes them less desirable. (See p. 19 also.)

Watery potatoes are always undesirable because they become soggy in cooking. Young tubers are more juicy than mature ones but their juice often holds so much more protein in solution that they cook with a pleasant waxy consistency. A good mealy potato should feel firm when pressed in the hand. If cut, it should separate crisply under the knife and be of even density throughout. If the core is large and soft, it will make a soggy mass full of holes in the center when cooked.

DIGESTIBILITY OF POTATOES.

In spite of the fact that potatoes are eaten by all sorts of people the world over and are generally conceded to be healthful as well as palatable, one occasionally hears it said that they are unwholesome. It has already been shown how little basis there is for the statement that they contain large quantities of cellulose and how much the danger of solanin poisoning is sometimes exaggerated. Better proof of their wholesomeness and digestibility than the facts of universal experience might seem superfluous. Still, much careful experimenting has been done to determine how much of each of the nutrients can be readily utilized by the body and the general effect of potatoes in the diet. Of course the real nutritive value of any material depends on the amount of nutrients which the digestive organs can make available for the formation of body material or the production of energy for its activities, rather than on the gross amount consumed. Almost the earliest digestion experiments with potatoes were made twenty-five or more years ago in Germany by Rubner, who experimented with a man accustomed to eating large quantities of potatoes, and kept him for two days on a diet of boiled potatoes, eaten either plain with salt or with oil and vinegar as a salad. As is common in such tests, he measured and analyzed the bodily excreta during the experiment, deducted the nutrients appearing in them from the amount consumed in the potatoes and let the difference between the two represent the amount available to the body. Such a diet is of course very irksome to a person accustomed to a more varied one, and it could hardly be expected that even with a subject used to large quantities of potatoes the digestive organs would do their work to the best advantage and it is not surprising to learn that there was some digestive disturbance. Nevertheless, 92.4 per cent of the carbohydrates and 67.8 per cent of the nitrogen were utilized by the body. In later experiments by Constantidini, the potatoes were made into a purée with milk and butter and in this more palatable diet 80.5 per cent of the total nitrogen was utilized and 99.5 per cent of the carbohydrates.

In Russia similar experiments were made, in which first a mixed diet and then potatoes alone were fed to healthy men. Here again 93 per cent of the carbohydrates were found to be digestible, but only 59 per cent of the protein. Later German experiments indicated a more thorough digestion of protein. Experiments have also been made under the auspices of this Department at the University of Minnesota. In these a mixed diet of eggs, milk, and cream, together with large quantities of potatoes, was given to a healthy young man for four days. The digestibility of the eggs, milk, and cream was already known and the digestibility of the potatoes alone was calculated by difference. Of the protein furnished by potatoes 71.9 per cent was [illegible] per cent of the carbohydrates. A series [illegible] men living on a mixed diet, includ- [illegible] and other vegetables, was made at [illegible] series there was considerable variation [illegible] protein by the three subjects, the results [illegible] and [illegible] per cent. There was less [illegible] of the carbohydrates, the figures being [illegible] The average digestibility of protein in [illegible] per cent and of carbohydrates [illegible] per cent. [illegible] the results obtained by the different inves- [illegible] to differences in method and to individual [illegible]

[illegible] of the ease or quick- [illegible] information is available on this point re- [illegible] In Beaumont's famous observations on a [illegible] with a gunshot wound in his stomach, roasted [illegible] found to pass through the stomach into the [illegible] hours and boiled potatoes in three hours. [illegible] The digestion of carbohydrates (the most [illegible] is accomplished mainly in the intes- [illegible] very little practical value. To the ordi- [illegible] makes little difference whether within [illegible] digests slowly or quickly, provided it

[illegible] evidence as to what form of cooking [illegible] but what little there is suggests that [illegible] methods are slighter than is com- [illegible] probable that well-cooked mealy potatoes [illegible] are thoroughly broken open offer less re- [illegible] digestive juices than ill-cooked soggy ones [illegible] broken down, which enter the alimentary [illegible] such differences are no one *really*

[illegible] OF POTATOES IN THE DIET.

[illegible] at [illegible] cents a bushel, 10 cents spent for [illegible] pounds of tubers. The same *sum* spent for [illegible] a pound loaf will purchase only 2 pounds of [illegible] it might seem that potatoes are *much* cheaper [illegible] so much more refuse, and especially water, [illegible] pounds furnish only about the same quan- [illegible] and slightly more carbohydrates than the 2 [illegible] that hardly more than one-half of the [illegible] a kind suitable to build body tissue, it is easy [illegible] their cheapness and similar composition they should not occupy the same place in the diet as bread. A diet of bread alone would be rather too one-sided for the best development of bodily powers, but would come nearer to supplying the required protein without excess of carbohydrates than potatoes alone. According to generally accepted standards, a man at moderately active work requires about one-fourth pound of protein a day, along with sufficient fats and carbohydrates to give the total food an energy value of about 3,500 calories. It would take about 9 pounds of potatoes to furnish this energy, but that amount would yield only about 0.12 pound of true proteid, or one-half of the amount called for by the standard. About 19 pounds of potatoes would be needed to yield the required 0.25 pound of true proteid, an obviously impossible bulk for a day's ration. The "potato belly," often spoken of as occurring among the European peasants accustomed to eating large quantities of potatoes, represents the attempt of the body to adapt itself to such conditions by distending the stomach and bowels. Except under the stress of necessity, however, no one lives entirely on potatoes. Ordinarily they are eaten with other foods rich in protein, such as meat, milk, eggs, etc., and thus supplement these nitrogenous foods by furnishing the needed carbohydrates. Their abundant mineral matters are also valuable in aiding the processes of digestion, and are supposed to prevent scurvy. As was stated above, their carbohydrates are very thoroughly digested. They are easy to cook, and can be prepared in so many ways that they add variety to the list of vegetable dishes, especially in winter, when green vegetables are not common. They have a mild, agreeable flavor acceptable to almost everyone, but which is not sufficiently pronounced to become tiresome. Owing to the ease with which they are grown and their abundant yield, they sell at a price within the reach of all.

Considering all these advantages, it is not surprising that in the temperate regions of Europe and America they rank next to the breadstuffs as a source of carbohydrates in the diet.

CETEWAYO, OR ZULU, POTATOES.

The Cetewayo, or Zulu, potato, a wild variety of *Solanum tuberosum* found in Africa, is sometimes grown as a garden vegetable for its flavor and novelty. It has practically the same percentage composition as the ordinary potato. When cooked, the flesh is purple in color, but when brought in contact with vinegar, as in salads, it turns red.

SWEET POTATOES.

The plants which we know in the United States as sweet potatoes are known to the botanists as *Ipomœa batata* or *Batatas edulis* and are probably natives of the Malayan Archipelago. They were introduced into Europe earlier than the white potato and were formerly so commonly grown in the warmer countries of Europe that when the white potatoes supplanted them the latter took their English name from a corruption of the usual European name of sweet potatoes—batates. Since then, however, they have fallen into disfavor in Europe, being considered too sweet to be used as vegetables and not sweet enough to fill the place of cakes, sweet fruits, etc. The few that appear in European markets come mainly from southern Spain, northern Africa, or the Canary Islands, and are rather poor in quality.

There are many cultural varieties of the sweet potato, which differ in color, size, and other characteristics of the tuber.

The Chinese and Japanese use one or two varieties similar to those grown in the United States, and others are said to be grown in the Pacific islands, but the chief present home of the sweet potato is the warmer regions of North and Central America and the West Indies. In the Southern States they play almost as important a part as the white potatoes do in other parts of the country, and they have almost usurped the name potato. They are also sometimes called yams, a name which really belongs to an entirely different order of plants, hardly known outside of tropical countries (see page 32). "Yam," however, is not applied so much to the dry, starchy varieties which are demanded by Northern markets as to the sweeter and more juicy kinds preferred in the South. The edible portion of the sweet-potato plant is not an underground stem, like the white-potato tuber, but a true root. Its internal structure is more uniform than that of the white-potato tuber, but its rôle in the life history of the plant is much the same—i. e., to act as a storehouse of plant food for the growth and early development of a new crop of plants. Above ground the plant is a vine which occasionally produces flowers (and in warm countries, seeds) resembling somewhat their relatives, the morning-glory; ordinarily, however, it relies on its roots for reproduction. The first touch of frost is fatal to the vines of most varieties, so the cultivation is limited to warm climates where the growth is practically continuous and the plants perennials or to regions where the summer is long enough to insure the ripening of a crop. Some varieties are more resistant to cold than others and are extensively grown as far north as New Jersey.

The color of the sweet-potato skin ranges from light tan to dark brown or red and purplish tones, and the flesh from almost white or pale lemon yellow to a deep reddish orange. The medium and lighter shades are most frequently seen in the Northern markets. The weight of the tubers also varies considerably, but those which are of medium size and of regular shape are to be preferred for the table, as they cook more evenly and may be prepared with less waste.

COMPOSITION AND NUTRITIVE VALUE.

In general chemical composition the sweet-potato root resembles the tuber of the white potato, although there are important differences between them. The average composition of sweet potatoes raw and cooked is given in Table 2, together with similar figures for the white potato.

TABLE 2.—*Average composition of sweet and white potatoes.*

Kind of potato.	Refuse.	Water.	Protein.	Fat.	Carbohydrates.		Ash.	Fuel value per pound.
					Sugar, starch, etc.	Crude fiber.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Sweet potatoes (edible portion)		69.0	1.8	0.7	26.1	1.3	1.1	570
Sweet potatoes (as purchased)	20.0	55.2	1.4	.6	21.9		.9	460
Sweet potatoes (cooked)		51.9	3.0	2.1	42.1		.9	925
Sweet potatoes (canned)		55.2	1.9	.4	40.6	.8	1.1	820
White potatoes (edible portion)		78.3	2.2	.1	18.0	.4	1.0	375
White potatoes (as purchased)	20.0	62.6	1.8	.1	14.7		.8	310

The proportion of total sweet potato discarded with the skin as refuse is probably about the same as in white potatoes, and is estimated at 20 per cent. The most noticeable differences between white and sweet potatoes are in the carbohydrates and water. Sweet potatoes contain on an average about 9 per cent less water and 9 per cent more carbohydrates than white potatoes. They also contain as little, or even less, protein; but as the proportion of true proteids is higher than in white potatoes, being about 1.3 per cent, they supply rather more tissue-building material to the body, pound for pound. This advantage, however, is hardly large enough to be of consequence. Nor does the fact that they contain a trifle more fat or ether extract give them a higher value in the ordinary diet.

More important than any of these differences is that in the nature of the carbohydrates. Sweet potatoes contain a slightly larger proportion of crude fiber than white, though the amount is no higher than in most vegetables. As would be guessed from their flavor, they contain considerable quantities of sugar, part of which is cane sugar and part invert sugar or glucose. The proportion of sugar and starch varies with the climate. The warmer the place in which the plant is grown, the greater the proportion of food laid by in the form of sugar. Tropical sweet potatoes sometimes contain almost equal quantities of sugars and starch. Those grown in New Jersey, on the other hand, probably do not average more than 5 or 6 per cent of sugar, or about one-fifth of their total carbohydrates. As sweet potato culture has developed during recent years, certain varieties have been evolved which tend to store more starch even in the South, but climate has so much influence that probably the dry, starchy roots demanded by northern markets will never be produced south of North Carolina. On the other hand, the sweet, sirupy "yams," prized especially in the South, could hardly thrive, except in the South Atlantic and Gulf States or the extreme Southwest.

When sweet potatoes are first harvested they are left for some time to "sweat," or to lose part of their moisture by evaporation before they are shut up in storerooms. Where they are grown on a large scale they are sometimes "kiln-dried," i. e., placed in a temperature at about 90° F. for a week or more. Ordinarily, however, it is more convenient and quite as desirable to dry them more slowly at a lower temperature. After the "sweating period" they should be stored in a dry, well-ventilated place at a temperature of 50 to 60° F. Little is accurately known about the chemical changes which take place during storage. Almost everyone has learned from experience, however, that late in the season they become watery and sometimes disagreeable in taste, especially if they have been left in a cold place, the peculiar and characteristic flavor often noted being due to a bacterial disease, a sort of dry rot. These undesirable changes may take place at any temperature below 50° F. To avoid the danger of shipping in cold weather, the southern sweet potato crop is usually sent north early in the autumn and stored near the retail market. New Jersey sweet potatoes are often buried in sand for the winter and sold in excellent condition late in the season. Housekeepers should be careful not to keep sweet potatoes in cold, damp cellars; in fact, many consider it safer to buy them in small quantities as needed. In choosing sweet potatoes at the market, firm, fresh-looking ones should of course be preferred to the old and shriveled roots, and medium sized, smooth roots are more satisfactory than very large or very small ones.

Early in the season unripe potatoes are sometimes marketed, and may be recognized by cutting them, as the flesh will soon turn dark green, whereas the properly ripened roots will not change in color.

As is the case with storage, our knowledge of the changes which cooking makes in sweet potatoes is confined mainly to the facts of common experience. There is no reason to suppose, however, that these changes, particularly with reference to the rupturing of cell walls and the swelling of starch grains, due to the absorption of water, etc., differ greatly from those which take place in white potatoes. One point is generally noticeable—the longer the cooking is continued the more moist does the root become. This is probably due to changes in the carbohydrates. Part of the starch is doubtless changed to soluble carbohydrates by the heat and then dissolved in the juice, and the cane sugar is inverted—that is, split up into simpler sugar. The very sweet southern varieties become so moist during baking that a sirup frequently exudes through the skin.

Sweet potatoes may be prepared for the table in many of the ways used for other starchy vegetables, and are also used for many special dishes where their sweet flavor is an advantage. In some parts of Asia they are preserved in sugar much as we preserve fruits.

Directions for cooking potatoes and other vegetables will be found in an earlier bulletin of this series.[a]

DRIED AND CANNED SWEET POTATOES.

Dried sweet potatoes were formerly a domestic product, and strings of them were hung from the rafters along with apples and other dried fruits and vegetables, but in these days of storage warehouses the custom has very largely passed away. Special devices for evaporating sweet potatoes are on the market, and desiccated sweet potatoes are prepared in much the same way as desiccated white potatoes and are sold to some extent. The South Carolina Experiment Station has devoted considerable attention to studying the possibilities of this industry.[b]

Within recent years the practice of canning sweet potatoes has been developed with so much success that it is now an important industry. Medium sized roots are usually chosen for canning, and they are generally put up in 3-pound tins. Canned sweet potatoes have been used in the army ration in the Philippines and are said to be in demand in lumber camps and mining camps. They are also used like other canned vegetables when it is not convenient to depend upon a fresh supply.

Although the bulk of the sweet potato crop is used for human food, some of the coarser kinds are fed to stock and a small part is used for the preparation of sweet potato flour—that is, sliced, dried, and ground tubers—and for the manufacture of starch.

DIGESTIBILITY AND PLACE IN THE DIET.

So far as can be learned, the only digestion experiments which have been made with sweet potatoes are those reported from Japan and quoted at length in a summary of Japanese investigations published by this Department.[c] Judging by these results, 98 per cent of the carbohydrates of sweet potatoes are digested, or about the same as in the case of white potatoes. The values for protein were very variable, but on the whole were lower than for protein of white potatoes.

It is a matter of common experience that sweet potatoes are wholesome and as a rule are digested by the average man without distress. Many persons find the starchy varieties so "dry" that they do not relish them without adding large quantities of butter. This makes a rather rich mixture and is perhaps accountable for the digestive disturbance occasionally experienced.

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[a] U. S. Dept. Agr., Farmers' Bul. 256.

[b] South Carolina Sta. Bul. 71; U. S. Dept. Agr., Farmers' Bul. 169, p. 25.

[c] U. S. Dept. Agr., Office of Experiment Stations Bul. 159, p. 174.

Considering both composition and digestibility, it may be said that the nutritive value of sweet potatoes is much the same as that of white potatoes and that they are well fitted to occupy the same place in the diet and furnish a palatable substitute for white potatoes. Further, their characteristic and pleasing flavor is an additional advantage. In the North they frequently cost somewhat more than white potatoes, but are still among the cheaper vegetables. In the South they are quite as cheap or cheaper than white potatoes, and merit their extensive use.

THE JERUSALEM ARTICHOKE.

The Jerusalem artichoke (Jerusalem being a corruption of "girasole," the Italian name for sunflower) is a tuber-bearing member of the sunflower family, as its Latin name, *Helianthus tuberosus*, implies, and is entirely distinct from the French or globe artichoke. Many farmers in this country are prejudiced against the Jerusalem artichoke, considering it an undesirable weed, but in Europe, and to a certain extent in the United States, it is believed to be a valuable plant, since the forage may be fed to stock, while the abundant tubers are useful as a vegetable and also for farm animals. In flavor the tubers slightly resemble the globe artichoke, and this doubtless accounts for their name. They contain on an average 78.7 per cent water, 2.5 per cent protein, 0.2 per cent fat, 17.5 per cent total carbohydrates of which 0.8 per cent is crude fiber, and 1.1 per cent ash. In the absence of accurate determinations it may be assumed that the waste in preparing the tubers for the table is the same as in the case of potatoes, namely, 20 per cent. Judged by these values the artichoke tubers are quite similar in composition to potatoes (see page 10). They differ, however, very markedly in respect to the nature of the carbohydrates which are present, inulin and levulin (which are closely related to starch chemically), and a considerable amount of pectose bodies replacing the starch which is characteristic of potatoes. It is owing to the absence of starch that Jerusalem artichokes are included in the vegetables permitted to patients suffering with diabetes. Little is known regarding the digestibility of the typical carbohydrates which these tubers contain, but it is commonly assumed that they do not differ materially from starch in this respect, and common experience has shown that the artichoke is perfectly wholesome and a pleasant addition to the diet, particularly as they are not injured by frost and may be dug in the spring when other fresh vegetables are not very common. As the plant is very prolific and easily grown, the Jerusalem artichoke is not an expensive vegetable.

STACHYS.

This vegetable, known to the botanists as *Stachys sieboldi*, has been introduced into America from Japan and has a number of different names, such as Japanese potato, Chinese artichoke, chorogi, etc., but the name stachys seems to have been adopted as the common one in this country. The plant is a small perennial belonging to the mint family and produces just below the ground a multitude of small white crisp edible tubers varying from an inch to two and one-half inches in length and about one-half an inch in thickness and marked by irregular spiral rings, which give them a corkscrew-like appearance.

Stachys has been tested at the New York (Cornell) and a number of the other agricultural experiment stations, and proved so easy of cultivation and pleasant in taste (the flavor resembling artichokes) that the vegetable has made many friends and is now procurable at the markets in most of our larger cities. The agreeable quality is in considerable measure due to the crispness of the tubers, and as this disappears when they are exposed to the air they should be stored in sand or sawdust. They are ready for use when the plant dies down in the autumn, though they may be easily carried over the winter and are prepared for the table like potatoes or other vegetables, or may be eaten raw like radishes. On an average, stachys has the following percentage composition: 78.6 per cent water, 2.7 per cent protein, 0.1 per cent fat, 17.4 per cent total carbohydrates (0.7 per cent being crude fiber), and 1.2 per cent ash. Like the other roots and tubers which have been spoken of, the stachys is characterized by a high water content, and carbohydrates constitute the principal nutritive material. According to some authorities inulin is present in stachys in place of starch, while others state that starch is replaced by a special carbohydrate called stachyose. A digestion experiment with stachys was made some years ago in Japan[a] and it was found that the carbohydrates were about as thoroughly digested as those of potatoes, 95 per cent being retained by the body.

TROPICAL STARCH-BEARING ROOTS.

In the Tropics a very large proportion of the carbohydrates of the diet of both native and European residents is furnished by starch-bearing roots, such as the cassava, yam, yautia, and taro. None of these are common vegetables in the United States, though some or all are sold in the oriental quarters of our cities and sometimes in a limited way in other markets, and the cassava and yautia are grown to some extent in the Southern States. In Porto Rico and our other island dependencies such starch-bearing roots are very important articles of diet, and as they may be readily shipped in good condition and are known to be palatable and wholesome it seems not unlikely that they may become important additions to the list of starchy vegetables commonly used in the United States.

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[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 159, p. 171.

The percentage composition of sweet cassava and some cassava products, taro, yams, and yautias is given in the following table, together with that of potatoes, for purposes of comparison:

TABLE 3.—*Average composition of some tropical starch-bearing roots.*

Kind of food.	Water.	Protein.	Fat.	Total carbohydrates.		Ash.	Fuel value per pound.
				Sugar, starch, etc.	Crude fiber.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Sweet cassava	66.0	1.1	0.2	30.2	1.8	0.7	610
Cassava starch	10.5	.5	.1	88.8		.1	1,625
Cassava bread	10.5	9.1	.3	79.0		1.1	1,650
Cassava cakes or wafers	10.3	1.1	.2	85.2	1.6	1.6	1,670
Taro	70.9	1.8	.2	23.2	.8	1.2	475
Yams	72.9	1.8	.2	23.3	.6	.9	475
Yautia tubers	70.0	2.2	.2	26.1	.6	.9	535
Potatoes	78.3	2.2	.1	18.0	.4	1.0	375

CASSAVA.

The cassava now being cultivated to a considerable extent in Florida, but rather as a cheap source of commercial starch, glucose, etc., than as a direct foodstuff, is an American plant widely used for food purposes throughout Central America, the West Indies, and the hot regions of South America. There appear to be two principal varieties, the sweet cassava and the bitter cassava, but only the sweet (*Manihot aipi*) is cultivated in the United States. The bitter cassava gets its name from the fact that the raw root contains considerable amounts of a poisonous prussic acid compound, which is volatile and may be removed by cooking, or even, it is said, by exposure to the hot sun. Both varieties are eaten as vegetables, boiled, baked, fried, or cooked in other ways, and by drying and grinding are made into a flour which forms the basis of various sorts of bread and biscuits. Round, thin, crisp cassava cakes are not infrequently on sale in the United States under a variety of trade names and are popular. Cassava starch is made in large quantities in the Tropics and has always been prized as a palatable and valuable food starch.

Judged by the figures given in Table 3, the cassava is as rich in starch as the potato, and like it can be classed as a succulent carbohydrate food. The amount of protein and fat present is very small, while the amount of mineral matter or ash is practically the same as in very many other common foods. The culture and uses of cassava and other related matters have been discussed in a previous publication[a] of this series.

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[a] U. S. Dept. Agr., Farmers' Bul. 167.

TARO.

The taro (known botanically as *Caladium colocasia* or *Colocasia antiquorum*), which is so commonly grown for its edible roots in the Tropics, is more familiar to most persons in the United States in one of its garden forms, namely the large-leafed ornamental plant sometimes called "elephants' ears." There are many varieties of this plant, and it constitutes one of the most important starch-yielding foods of native races in southern China, India, the West Indies, etc. It has a rather disagreeable, acrid taste when raw, but this disappears on cooking. The root may be eaten boiled, baked, or cooked in other ways, and a sort of flour is also made from it. The native Hawaiians eat it in the form of poi—a sticky dough-like dish which is allowed to ferment before it is used.

The composition of taro has been studied in connection with the nutrition investigations of this Office at the University of California.[a] As the figures quoted in Table 3 show, it does not differ very materially from potatoes in composition. Judged by a digestion experiment made in Japan,[b] the carbohydrates of taro compare favorably in digestibility with those of other starchy roots, 95 per cent having been assimilated.

YAUTIA.

The yautia, which is closely related to the taro botanically, though it belongs to a different group known as Xanthosoma, is a very important starchy food in the West Indies, where it is known by a variety of names, such as taniers or tannias, cocoes, eddoes, taye, etc. The cultivated varieties do not produce seed, though they occasionally put out abortive blossoms. The plants will thrive in almost any moist region free from frost and produce a large crop of roots in return for comparatively little cultivation. In Porto Rico every small farmer has his plat of yautias, and next to sweet potatoes and yams they are the most important native food crop. The flesh of the different varieties ranges in color from white to deep orange red. Both root stalks and the tubers which grow from them are edible, though the tubers are considered the more tender and of better flavor.

The culture and uses of the yautia and related questions have been discussed in full in a recent bulletin[c] of the Porto Rico Experiment Station.

The thin skin is usually removed before the yautias are cooked, and this entails on an average a loss of about 5 per cent of the total weight of the tubers. Yautias are cooked as a vegetable in many ways like potatoes, and a starch is sometimes made from them which is used for making puddings, cakes, etc. In connection with the nutrition investigations carried on by the Office of Experiment Stations, a number of tests were made of the culinary qualities of yautias, taro, and yams supplied by the Porto Rico Experiment Station, and it was found that these vegetables could be readily prepared for the table like potatoes in a number of appetizing ways.

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[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 68.

[b] U. S. Dept. Agr., Office of Experiment Stations Bul. 159, p. 171.

[c] Porto Rico Sta. Bul. 6.

YAMS.

The true yams (Diascorea), which are often confused with sweet potatoes (see p. 24), belong to a group of climbing plants. The number of varieties found throughout the Tropics and subtropics is very large and many of them bear edible starch-yielding roots which vary greatly in size, some being no larger than potatoes and others several feet in length and weighing 30 pounds or more. The true yams are grown extensively in southern China, Oceania, Porto Rico, the West Indies and other tropical regions and are very important sources of carbohydrates in the diet, ranking in Porto Rico, for instance, next to the sweet potato.

When used as a vegetable they are boiled, roasted, or cooked in other ways like the potato, or may be made into a sort of flour and used as a breadstuff. The flours and starches prepared from the yams and other tropical roots of course differ from wheat flour in that they contain no true gluten. The flesh of many of the commoner yams is white, though certain varieties are yellow fleshed and very much like a sweet potato in appearance. In flavor the yam very closely resembles the white potato, and, as may be seen by the figures for average composition in Table 3, also resemble the potato in composition. In the cooking tests already referred to above, some of the yams used were of the large white varieties, weighing several pounds. These were cut in convenient slices, cooked like potatoes, and could hardly be distinguished from them in flavor or appearance. The Japanese investigations noted elsewhere (p. 27) include a study of the digestibility of yams, and 96 per cent of the total carbohydrates was found to be assimilated.

SUCCULENT ROOTS, TUBERS, AND BULBS.

There are a number of common root vegetables which resemble each other in so many points that they may be conveniently grouped together for discussion. Prominent among these are beets, carrots, turnips, parsnips, etc. In many cases the leaves and stems are also used as pot herbs or "greens," especially while they are young and tender. Most of these vegetables have developed from wild forms whose roots are small, tough, and possessed of stronger flavor and odor than the cultivated varieties. Since earliest times the ordinary succulent roots have been common garden crops. They are cheaply grown in almost any temperate region and are very generally used as food.

There are also a number of these roots grown for the table in Europe and elsewhere which are not often seen in the United States but which agree in general character with those referred to above. Parsnip-chervil, Spanish salsify, and Teltow turnips may be cited as examples. Among the succulent roots used by the Chinese and other Orientals, but not commonly used by western races, may be mentioned arrowhead, sacred lotus, and water chestnut. These were included in a study[a] of Chinese foods sold in this country, which was made at the California Experiment Station in cooperation with the nutrition investigations of the Offices of Experiment Stations.

Of the bulbs used as food in the United States, various members of the onion family are the only ones which need special mention, though lily bulbs of different sorts are eaten by the Chinese and may be purchased in our large cities, and various wild bulbs have always been gathered as food by the Indians.[b]

The following table shows the composition of the succulent roots, tubers, and bulbs commonly used as food, as well as the composition of potatoes, which is included for purposes of comparison.

TABLE 4.—*Average composition of succulent roots, tubers, and bulbs.*

Kind of vegetable.	Refuse.	Edible portion.						
		Water.	Protein.	Fat.	Carbohydrates.		Ash.	Fuel value per pound.
					Sugar, starch, etc.	Crude fiber.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Beets, fresh	7.0	87.5	1.6	0.1	8.8	0.9	1.1	215
Beets, cooked		88.6	2.8	.1	7.4		1.6	185
Celeriac	20.0	84.1	1.5	.4	11.8	1.4	.8	285
Carrots, fresh	20.0	88.2	1.1	.4	8.2	1.1	1.0	210
Carrots, desiccated		3.5	7.7	.6	80.3		4.9	1,790
Parsnips	20.0	83.0	1.6	.5	11.0	2.5	1.4	300
Salsify "Oyster plant"	25.0	85.4	4.3	.3	6.8	2.0	1.2	250
Black salsify	20.0	80.4	1.0	.5	17.1	2.3	1.0	390
Radishes		91.8	1.3	.1	5.1	.7	.1	135
Turnips, white	10.0	89.6	1.3	.2	6.8	1.3	.8	160
Turnips, yellow (ruta-bagas)	10.0	88.9	1.3	.2	7.3	1.2	1.1	185
Kohl-rabi	20.0	91.1	2.0	.1	4.2	1.3	1.3	145
Onions	30.0	87.6	1.6	.3	9.1	.8	.6	225
Garlic		64.7	6.8	.1	27.9	.8	1.5	650
Potatoes	20.0	78.3	2.2	.1	18.0	.4	1.0	375

As a rule the succulent roots, tubers, and bulbs contain larger quantities of water than the starchy vegetables described in the preceding sections and consequently have a lower nutritive value. The proportion of protein which they contain is low, and of this small amount not more than a third, and frequently only a fifth, is in the form of albumin or similar compounds. Various sugars, pectose bodies, and, in some cases, pentosans, very generally constitute the reserve material which the plants store up instead of the starch characteristic of such roots as the potato and sweet potato. As a class these vegetables are characterized by very marked flavors and odors due to the small amount of volatile oils and similar substances which they contain.

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[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 68.

[b] U. S. Dept. Agr., Div. Botany, Contrib. U. S. Nat. Herbarium, vol. 7, No. 3.

Succulent roots, tubers, and bulbs, when considered from the standpoint of the protein, fat, and carbohydrates which they supply, are much less important components of the diet than concentrated cereal foods or even the comparatively succulent starchy roots and tubers. They do, however, furnish some nutritive material, and are appetizing and generally relished, and their use often makes palatable an otherwise comparatively flavorless dish or meal. Furthermore, they contribute bulk to the diet, and this is an important consideration from the standpoint of normal digestion. Perhaps one of the most important functions of these succulent roots, etc., as indeed of most of our common vegetables and fruits, is to supply the body with mineral salts which are needed for the building and repair of tissue, for the proper carrying out of physiological functions, and particularly to insure the alkalinity of the blood.

The ways in which these and other vegetables may be prepared for the table are very numerous and have been discussed in an earlier bulletin of this series.[a]

The various vegetables included in the above table each have some special characteristics which merit discussion and so they will be taken up separately.

BEETS.

Although the greater part of the total crop of beets or beet root, as they are called in Great Britain, is used for the production of sugar or for the feeding of farm animals, yet beets are used in such large quantities as a human food that they rank as one of the most common table vegetables. White or yellow table beets are occasionally to be seen, but the red ones are the most common. The flavor is more delicate in the summer varieties than in the later maturing sorts. Each year the southern-grown beets are becoming more common in our winter market and are superseding the large fully matured roots which were formerly so often stored as winter vegetables and which late in the season often develop a rather bitter and unpleasant flavor. It is sometimes said that beets are more nutritious than turnips, carrots, etc., but a comparison of the values for average composition given in Table 4 does not substantiate this statement, all these vegetables being very much alike as regards the proportion of nutritive material present.

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[a] U. S. Dept. Agr., Farmers' Bul., 256.

Cane sugar constitutes a considerable portion of the total carbohydrates of beets, as high as 10 per cent or more having been often reported. Some reducing sugar is also present. In beets grown for sugar making the percentage of cane sugar is considerably higher, sometimes 20 per cent or more, though such high values are the exception. Beets are sometimes said to be very rich in cellulose, but this does not seem to be the case with American varieties whose average composition has been quoted. When beets are cooked the water becomes highly colored, and it is undoubtedly true that a considerable part of the sugar and other soluble nutrients which they contain is extracted, but how much material is removed can not be stated as no cooking experiments with beets have been found on record.

Three digestion experiments were made several years ago at Wesleyan University in which it was found that 72 per cent of the protein, 97 per cent of the carbohydrates, and 90 per cent of the total energy value of the beets were utilized by the body, figures which compare very favorably with those obtained with potatoes in tests made with the same subjects.

Beets are frequently canned at home for winter use and the commercial canned article is a very well-known product. As regards composition, the canned goods have practically the same chemical composition as freshly cooked beets.

CELERIAC.

This vegetable, which is also known as turnip-rooted celery, or knot celery, is closely related to our ordinary celery, being indeed a cultural variety of the same original plant grown under conditions which have developed the root rather than the stalk. In Europe it is by far the most common form of celery, but has never been extensively cultivated in the United States, though it is found in the larger markets. The roots are white and more or less globular in shape, closely resembling turnips in appearance. As the figures in Table 4 show, they have much the same composition as the other succulent roots and tubers. Celeriac has a pronounced celery flavor due apparently to a complex oil like that in the seed, which is rather stronger than that of the tender celery stalks, but when cooked celeriac does not differ very greatly in taste from ordinary stewed celery.

A German investigator has reported mannit, a starch like carbohydrate, and also small amounts of asparagin, a constituent of asparagus, in tuberous-rooted celery. So far as can be learned no digestion experiments have been made with this vegetable, but it would doubtless differ little in digestibility from beets or other succulent roots.

It is often said that celery is a nerve food, but there seems to be no warrant for such a statement, and the belief is probably a survival of the time when specific virtues were attributed to almost all plants and vegetables.

CARROTS.

Carrots are grown in many varieties, and vary greatly in color, size, flavor, and other characteristics, those most commonly raised for the table being of medium size, deep yellow color, tender, and of delicate flavor. Young carrots are much more satisfactory than old ones, as when fully matured they tend to become hard and woody, especially at the core, while not infrequently the flavor of old carrots is disagreeably strong. Some varieties are more satisfactory than others for winter use, but the winter carrots are, generally speaking, more used for seasoning soups and other dishes than as a table vegetable. Improved methods of transportation, storage, etc., have, moreover, made the small tender southern-grown carrot comparatively common as a winter vegetable.

In composition carrots do not differ very materially from other similar roots, carbohydrates constituting the principal nutritive material. Sugar is an important constituent, 12 per cent or more being sometimes present, though perhaps 5 or 6 per cent would more nearly represent the average. Small amounts of pentosans have also been reported. The proportion of sugar in the carrot, beet, and other vegetables is very variable, being influenced by size, maturity, method of storage, and other factors. Carrots owe their color to the presence of a yellow organic compound known as "carrotin," which is sometimes extracted with the juice and used for coloring butter.

The water in which carrots have been boiled is quite yellow and has a sweet taste, plainly showing that some of the nutrients have been removed in the process of cooking. In order to determine the amount of this loss, experiments were made with carrots at the University of Minnesota, similar to those made with potatoes referred to on page 14. The carrots were cleaned and cut into pieces of various sizes and then boiled in different ways. Whether the water was hot or cold at the start made less difference than in the case of potatoes, but it was found that the more water used, the greater were the losses. On the other hand, the more rapidly the carrots were boiled, the smaller was the loss. Small pieces, doubtless because a relatively large surface was exposed to the action of the boiling water, lost about 30 per cent of their total nutrients, 20 per cent of the true proteids, and 26 per cent of sugar, while large pieces lost only 20 per cent, 5 and 16 per cent, respectively. Figure 4 represents in graphic form the composition of the carrot and the loss of nutrients when boiled.

A European investigator[a] found that when carrots were steamed they became soft a little more quickly than when cooked in hot water and lost considerably less material, as the water over which they were steamed contained only 0.69 per cent of the total material as compared with 3.75 per cent in the case of the water in which they were boiled. The material extracted from the carrots in cooking consisted principally of sugar or similar carbohydrate.

A number of years ago a German investigator studied the digestibility of carrots, and found that about 60 per cent of the protein and 80 per cent of the carbohydrates were retained in the body. His results were too meager to justify general deductions, and it seems probable that the vegetable would, generally speaking, be as digestible as beets or potatoes. Carrots are commonly considered to be wholesome and a valuable addition to the diet, both as a seasoning vegetable and cooked in a variety of ways.

Dried or desiccated carrots are on the market and are recommended for use wherever small bulk and good keeping qualities are important considerations. These goods resemble the fresh carrots in composition, except that they have been concentrated by the evaporation of water.

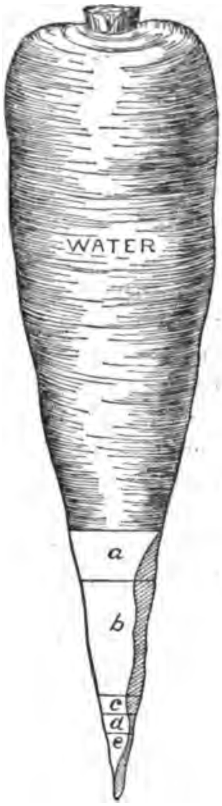

FIG. 4.—The composition of the carrot and the loss of nutrients when boiled: *a*, fiber, starch, fat, etc.; *b*, sugar; *c*, nonproteid nitrogenous matter; *d*, proteid nitrogenous matter; *e*, mineral matter. The hatched portion represents the loss when medium-sized pieces were boiled.

PARSNIPS.

Parsnips belong to the same botanical order as carrots and resemble them in form and general habit of growth. The flesh of the root, however, is paler, being white or light cream color, and the flavor is quite distinct and very pronounced. Parsnips may be kept in the ground over winter and are especially welcome additions to the diet in early spring, when vegetables which have been stored are losing their good qualities. For some reason boiled parsnips were long considered in some regions of Europe to be the proper vegetable to serve with salt fish, but this tradition is not followed in the United States, and they are cooked and served in a variety of ways, as are the other vegetables which they closely resemble.

As regards composition, parsnips are much like the other roots and tubers, but contain rather higher quantities of cellulose, particularly in the core, which becomes stringy and woody when the roots are old. How much of the total nutritive material is lost in boiling is not definitely known, but it is commonly thought to be considerable. The amount is doubtless affected by the same conditions as were noted with carrots. So far as can be learned no digestion experiments have been made with parsnips.

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[a] Landw. Jahrb. Schweiz., 19 (1905), p. 619.

SALSIFY.

The name "salsify" is commonly applied to three distinct vegetables, namely the common white salsify known as "oyster plant" or "vegetable oyster" (*Tragopogon porrifolius*), black salsify (*Scorzonera hispanica*), the schwarz wurzel of the Germans, and the so-called Spanish salsify (*Scolymus hispanicus*). The first of these is very commonly grown in the United States, and black salsify is also grown though less extensively, while Spanish salsify is seldom cultivated. Both common salsify and black salsify closely resemble the other succulent roots used as food in general character. They are not injured by mild frosts and may remain in the ground until late winter or early spring. As the popular name of salsify implies, the flavor suggests that of oysters.

The principal carbohydrate stored in black salsify is inulin rather than starch, and so this vegetable is often used in the diet of diabetics. The proportion of materials lost in cooking and the digestibility have not been made the subject of investigations so far as can be learned, but there is every reason to suppose that salsify would resemble the other succulent roots in these respects.

RADISHES.

The radishes most commonly grown in the United States are those with red exterior and white flesh, although white and dark purple varieties are also well known. Though formerly red radishes were a typical spring vegetable they are now so commonly grown under glass that they are available all winter in large markets. To be at their best, radishes should be eaten before the roots are fully mature and should be very fresh. Besides losing their crispness they become sweeter in taste if they are kept long after they are gathered, owing to the action of a ferment or enzym normally present which changes part of the radish starch to sugar. Similar enzyms are found in beets, carrots, etc., but in these vegetables their action is less marked.

As will be seen from the figures in Table 4, the young radishes analyzed contained even more water than the turnips. The characteristic pungent flavor is due to organic compounds similar to the essential oil of mustard. Radishes are almost always eaten raw, and are so succulent and tender that they are doubtless rather thoroughly assimilated, though so far as can be learned their digestibility has not been studied. It is frequently said that they are productive of digestive disturbances. Whether this is attributable to the crude fiber which they contain or to the bodies which give the high flavor or to both together it is not possible to say, but such digestive disturbances are by no means general, and when they occur may be due to the fact that succulent foods are frequently swallowed without sufficient mastication.

TURNIPS.

A great variety of turnips is grown throughout temperate climates, some of which being course in texture are used as food for farm animals while other varieties are raised as table vegetables. There is considerable variation in the color, flavor, and composition of the turnip, the yellow-fleshed sorts as a group being commonly distinguished from the white by the name "Swedes" or "ruta-bagas." In the summer the early white varieties are usually preferred in spite of the fact that they are more watery, while in winter the yellow turnips are more commonly used. Solid as the turnip roots appear they contain on an average about 89 per cent of water or a trifle more than is found in whole milk. Only about 20 per cent of the total protein present is in the form of albumin. Carbohydrates are the principal nutritive material, glucose, cane sugar, pectose or jelly-yielding bodies, pentosans, and crude fiber being the characteristic carbohydrates present. The flavor of turnips is due to compounds of sulphur, which are so volatile that when turnips are fed to cows they pass through the body tissues and into the milk and give it an unmistakable flavor of turnips. In cooking, these pungent substances are broken down to some extent and pass off into the air. So far as can be learned no accurate data are available regarding the digestibility of turnips, but they are commonly conceded to be wholesome, palatable, and useful additions to the diet, and there is no reason to suppose that they are not well assimilated.

KOHL-RABI.

Kohl-rabi, or turnip cabbage, represents a curious variety of the turnip and cabbage families in which the reserve material of the plant is stored in a tuber-like enlargement of the stem just above the surface of the soil rather than beneath. Although, strictly speaking, it does not belong to the roots and tubers, it is so similar to them that it has been included in this discussion. Kohl-rabi is considered best in the early summer, when it is still young and tender, but it is commonly found on the market until late fall. In flavor it is more delicate than either turnips or cabbage, though it resembles them more nearly in this respect than it does other common vegetables.

ONIONS, GARLIC, ETC.

The various members of the onion family are so commonly used for flavoring purposes that they should perhaps be included with the flavoring vegetables. Such classifications as those followed in this bulletin are, however, of course, purely arbitrary, and in the case of the onion family some varieties are so largely used as vegetables that it has seemed best to discuss them in connection with the roots, tubers, etc., as they are used in practically the same way in the diet. All the members of the onion family are characterized by very strong flavor and odor due to the presence of characteristic oil-like organic compounds of sulphur, which vary somewhat in flavor and composition with different varieties of the plant and are usually more abundant in the bulbs or roots than in the leaves or other parts. They are very volatile and are broken down by heat to some extent and consequently the cooked vegetable has a much milder flavor than the raw.

The common onion in its many varieties is the best known and most used in the United States of the onion family. The total crop produced is very large, and quantities are also imported from southern Europe, Bermuda, and the West Indies. As with most vegetables, the young and somewhat immature onions are preferred to the fully matured bulbs, though the latter have the best keeping qualities. White varieties are milder in flavor than the red or yellow sorts and are generally preferred as table vegetables. If they are to be kept through the winter, onions should be taken from the ground as soon as the stalks begin to wither and cured or dried in the air for about ten days. If the moisture is not thus removed before they are stored they will not keep well.

The proportion of water and nutrients in onions varies greatly, not only with the variety but with the stage of growth and the method of storing them. Roughly speaking, the chemical composition is very similar to that of the succulent roots also included in Table 4. They contain, however, rather larger quantities of cellulose, particularly in the outer layers, which are usually removed before cooking. The waste in preparing onions for the table may be as high as 50 per cent, but 20 or 30 per cent is perhaps a fairer average. The onions are succulent and tender, and there is every reason to suppose that they are as thoroughly digested as other similar vegetables, though so far as can be learned this question has not been made the subject of definite investigation. They are commonly conceded to be wholesome and have been prized since earliest times as a valuable addition to the diet. The characteristic sulphur bodies which they contain are believed to stimulate the flow of digestive juices, and these and other constituents have a desirable effect in overcoming a tendency to constipation. As onions contain no appreciable amount of starch and little sugar they are usually allowed to invalids from whose diet starchy foods are excluded.

Garlic is a member of the onion tribe, which forms a group of small bulbs called "cloves" in the place of one large bulb, as with the more common varieties of the onion. It is used almost exclusively as a flavoring plant, though some of the mild sorts grown in the Mediterranean region are eaten as a vegetable. In this country it is little eaten save by some of the foreign population, and this is perhaps unfortunate, as rightly used it undoubtedly adds much to the palatability of salads, meats, and other dishes.

Shallot, cibol, etc., are varieties of the onion family much esteemed for their flavor in Europe though they are not common in the United States. Leeks and chives, two other sorts, develop almost no bulbs and are grown for their leaves, leeks being used as a green vegetable or pot herb and chives as a salad plant or for seasoning. Although most families in the United States are familiar with onions only, many good cooks consider that the other members of the group are also indispensible for seasoning purposes.

ROOTS USED AS CONDIMENTS.

Several roots have pronounced aromatic qualities which give them a value quite independent of the nutritive material which they contain. In addition to increasing the flavor of food it seems possible that such condiments may stimulate the flow of digestive juices as well as please the palate. Horse-radish and ginger are the most common condimental roots, though chicory, which is commonly considered in Europe a palatable addition to coffee, may also be mentioned, as well as licorice root and calamus or sweet flag.

Horse-radish is a moisture-loving plant of the mustard family which is cultivated throughout north temperate countries and is very frequently found wild in the United States, as it long ago escaped from cultivation. The root is long, slender, and has a sharp, peppery flavor, owing to the presence of an essential oil which much resembles in general character that in the radish and other members of the mustard family. As regards composition, horse-radish contains on an average 86.4 per cent water, 1.4 per cent protein, 0.2 per cent fat, 10.5 per cent total carbohydrates, and 1.5 per cent ash, and has a fuel value of 225 calories per pound. The root contains a large proportion of water. Starch constitutes the principal carbohydrate present, and, as might be expected from the stringy character of the roots, the percentage of crude fiber is rather high. Though varieties of horse-radish are sometimes cooked as a vegetable, and it is used for seasoning meat, sauces, etc., it is perhaps most commonly used in this country mixed with vinegar as a condiment. It is popularly supposed that the vinegar softens the crude fiber to some extent and makes it more digestible.

Ginger, the underground root stock of *Zingiber officinale*, is perhaps most commonly used dry as a spice, though the fresh root or green ginger is common in autumn, being used in pickle making, preserving, and in other ways. The young and tender ends of the branching root or rhizome, called ginger buds, are the most delicate portion as regards both texture and flavor. Large quantities of ginger root are preserved in rich sugar sirup, the round stone jars of "Canton ginger" being an old-fashioned confection which is still much prized. The crystallized or candied ginger is even more common and is frequently served as a sweetmeat, and is also used in making deserts of various sorts. While the nutritive value of preserved and crystallized ginger depends, of course, quite largely on the added sugar, the fresh root contains some nutritive material, the average composition being 85.6 per cent water, 1.0 per cent protein, 0.6 per cent fat, 11.4 per cent sugar, starch, etc., 1.0 per cent crude fiber, and 1.4 per cent ash, and has a fuel value of 240 calories per pound. Of the total fat or ether extract, about half consists of the ethereal oil, which together with a pungent nonvolatile constituent "gingerol," gives to ginger its characteristic flavor.

SUMMARY.

The plants which store their reserve material in underground roots, tubers, and bulbs have in many instances come to be regarded by man as among the most important foodstuffs. Cultivation has to a great extent modified the size, structure, flavor, and appearance of the plant parts which are eaten, and the garden varieties are as a rule superior to the wild in these respects and show important modifications in the season of growth and in other ways. As a class the edible roots, tubers, and bulbs may be divided into the following groups: (1) Starch-yielding vegetables, as potatoes and sweet potatoes; (2) succulent roots, as beets, carrots, and parsnips; and (3) condimental or flavoring roots, as horse-radish and ginger. Such plants as garlic and onions might be included in the last group, but are here considered with the succulent roots as some of the milder flavored varieties are eaten in such quantities that they may be fairly considered as foods rather than simply as flavoring vegetables.

As a class the edible roots, tubers, and bulbs have a high-water content and are valued as additions to the diet for their appetizing, succulent qualities and the bulk which they give as well as for the nutritive material which they supply. Starch is the material most commonly stored in these underground receptacles of nutritive material, though it is not infrequently replaced in some plants by inulin, a closely related body, by sugars of different sorts, pectoses, and other carbohydrates. The proportion of nitrogenous material in such foodstuffs is small, and true albumin seldom constitutes more than a third of the total protein. The proportion of fat or ether extract is also small, being composed in some cases very largely of wax-like bodies found in the skin, or of coloring matter; and in other cases, of volatile oils and similar substances which give the plants their characteristic flavor and odor. The mineral matter or ash is an important constituent of these vegetable foods, the proportion though small being about the same as is found in many other common articles of the diet. Sodium, potassium, and iron salts, and sulphur and phosphorus compounds, etc., are the common ash constituents. As the mineral matters exist in combination with organic acids and other bodies they contribute materially to the flavor of the tubers, roots, etc.

In tropical regions yams, cassava, and other starch-bearing roots seldom seen in northern markets are among the most important vegetables and are cooked and served in a variety of ways. Starch is frequently made from these roots, and they are also used in the production of a sort of meal or flour eaten in large quantities. In temperate and northern regions the potato is the leading starch-yielding vegetable.

The potato varies considerably in composition with age, variety, and conditions of growth. The ripened tubers are usually richer in starch and have better keeping qualities than the immature tubers, but the latter contain larger proportions of mineral matters, acids, etc., and are consequently of richer flavor. Cooking breaks down the cellulose walls of the potato cells which inclose the starch grains, gelatinizes or hydrates the starch so that it becomes softer and looser in structure, and improves the flavor largely by volatilizing acid bodies and similar constituents or otherwise modifying their character. In young tubers, which usually contain a larger proportion of protein to starch than the mature ones, the heat of cooking causes the protein to coagulate or harden around the starch, producing a "waxy" rather than a "mealy" mass. When potatoes are peeled before cooking, some nutritive material is usually removed with the inedible skin, the total material removed (designated refuse in food analyses) being on an average 20 per cent. When potatoes are cooked some water is usually lost by evaporation, and the loss of nutritive material may, under certain circumstances, be also quite considerable. Thus, when potatoes were peeled and soaked before boiling the loss of food material has been found to be, in round numbers, as much as 7 per cent of the total dry matter. Much smaller quantities are lost if the potatoes are not soaked, and when they are baked or boiled in their jackets the loss of nutritive material is insignificant. During storage potatoes lose water by evaporation, and this loss may be so great that the tubers become shriveled. Some of the starch which is present is changed to sugar, especially if the tubers are frozen or if they begin to sprout. Minute quantities of a poisonous substance of very pronounced flavor, solanin, are found in potatoes, and to this constituent they very largely owe their characteristic flavor. In old or sprouted potatoes the amount of solanin may be great enough to cause illness. When such tubers are used for the table, the flesh around the sprouts should always be carefully cut away, as this is more likely to contain solanin than any other portion. Under ordinary conditions the chance of any injurious effects from solanin in potatoes is very remote, and they are generally conceded to be among the most wholesome and useful starch-yielding foods, particularly when it is remembered that digestion experiments have shown that the starch and other nutritive material which they supply are very well assimilated by the body. Although they contain too small a proportion of the tissue-building proteid in proportion to their carbohydrates to provide a satisfactory ration if used alone, they are admirably fitted for combination with milk, meat, eggs, and other proteid foods to form a palatable well-balanced diet.

Sweet potatoes are common starch-yielding vegetables throughout the United States, and the proportion eaten in the Southern States, where the bulk of the crop is produced, is much greater than in other localities. Much of the reserve carbohydrates these tubers contain is in the form of sugar. In the South varieties so rich in sugar that they become sirupy in cooking are considered superior, but in the northern markets the starchy sweet potatoes are preferred. Some varieties of sweet potatoes are frequently called yams, but this name properly belongs to a distinct order of tropical plants which yield edible tubers, some of them of very large size and others closely resembling sweet potatoes in form and appearance, though they lack the characteristic sweet flavor.

Beets, carrots, parsnips, salsify, turnips, and onions are the most common of the so-called succulent root crops used as food. They differ from the starch-yielding vegetables like potatoes mainly in containing a larger proportion of water, 85 to 90 per cent on an average, and consequently a smaller proportion of nutritive material. Furthermore, it is generally true that starch is not the characteristic carbohydrate of these vegetables, its place being taken by sugars of different sorts, pectose bodies, and other similar carbohydrates, while the percentage of crude fiber is also rather higher than in the edible starch-yielding roots and tubers. Many of the vegetables included in this group are characterized by marked flavors and odors due to the presence of volatile organic sulphur compounds in their juices. In the members of the onion tribe these are especially strong, and some varieties are used almost exclusively as flavoring materials, while other and milder sorts are also used in large quantities as table vegetables.

Though not very nutritious in proportion to their bulk, root crops as a class offer some advantages over most other vegetable foods. They are so easily grown and are so productive that under ordinary conditions they sell at prices within the reach of all. Many of them may be kept over winter in such good condition that they are never out of season. The carbohydrates, the principal nutritive mateiral present, are in forms which are readily and well assimilated. The characteristic flavor which some of these vegetables possess is a decided advantage, as it makes the vegetables palatable and adds to the variety of the diet. Succulent vegetables of all sorts contribute bulk to the diet, and so are valuable from the standpoint of hygiene, as within limits bulkiness is a favorable condition for normal digestion and also of importance in overcoming a tendency to constipation. In addition, the mineral salts which they contain serve an important purpose in helping to maintain the alkalinity of the blood and have other physiological uses.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 296.

Experiment Station Work,

XLI.

Compiled from the Publications of the Agricultural Experiment Stations.

WELLS AND PURE WATER.
PHOSPHATES AND SOIL ACIDITY.
PURE SEED v. POOR SEED.
DISEASE-RESISTANT CLOVER.
ERADICATION OF WILD MUSTARD.
STERILIZATION OF SOILS FOR PREVENTING PLANT DISEASES.
SEEDLESS TOMATOES.
PICKLING OLIVES AND MOCK OLIVES.
HAY BOX OR FIRELESS COOKER.
INSECT ENEMIES OF SHADE TREES.
FEEDING WHOLE GRAIN.
IMPROVEMENT OF CATTLE.
VENTILATION OF STABLES.
HOG COTS.
PRESERVING EGGS.
AMERICAN CAMEMBERT CHEESE.

MAY, 1907.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

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1907.

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[a] Director. [b] Assistant director. [c] Special agent in charge. [d] Acting director.

EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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2. Wigwam hog cot used at Wisconsin Station.......................... [illegible]

3. Large size hog cot.................. .... [illegible]

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EXPERIMENT STATION WORK.[a]

WELLS AND A PURE WATER SUPPLY.[b]

In a discussion of the disposal of dairy and farm sewage in such a way that the water supply may not be injured, O. Erf, of the Kansas Experiment Station, draws some general deductions regarding the construction and care of wells which are of much interest.

It must be borne in mind that the well on a dairy farm and, indeed, on any farm or in any dooryard, can not receive too much care, for it supplies the water for household use, for the dairy farm, for cheese factories, and for other purposes which are related to food supply. Well water is most commonly contaminated in two ways, either by surface water, which runs directly into the well, or by barnyard drainage, household slops, and cesspools.

Sewage disposal may be so managed that it is not a menace to the water supply, one of the most satisfactory methods employing a septic tank, and, as the Kansas experiments show, this need not involve any great trouble or expense.

Discussing well construction, the Kansas bulletin states that—

> Nearly all of the bacterial life exists in the upper strata of the soil. Soil 10 or 12 feet below the surface of the earth is perfectly sterile, unless it has within it a crevice or opening so that surface sewage can run down. Therefore due care should be taken in digging and constructing a well so that direct contamination will be prevented.
>
> The well itself must be so constructed that the impurities can not get into it from above or from the sides. Water should be filtered through 10 or 12 feet of fine soil. To prevent the surface pollution a water-tight wall should be built in a well down below the water level. This can be built of hard, burned brick and cemented on the outside. Clay should be pounded around this.
>
> Where drilled wells are used the lining of the well should be an iron tube driven into the bore and the outside should be flushed with thin cement. The well should be properly covered and the surrounding ground should be considerably higher than the general level of the soil. The walls should extend at least 3 feet above the surface of the ground and a ground fill made so that it will slope from the wall. The top of the fill should be covered with at least 12 inches of clay or loam, upon which it is advisable to have some sod or a layer of sand or, best of all, a pavement sloping in all directions.

If due precautions are taken in the disposal of sewage, care of waste and garbage, and in the proper construction of wells, there is little danger of well water becoming polluted. An abundant supply of pure water[a] is a great step toward insuring the health of the household dependent upon the well, and increasing the wholesomeness and healthfulness of the butter, milk, cream, and other products sold from the farm.

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Kansas Sta. Bul. 143.

AVAILABILITY OF PHOSPHATES IN RELATION TO SOIL ACIDITY.[b]

In an article on this subject in the last report of the Wisconsin Experiment Station A. R. Whitson and C. W. Stoddart call attention to the fact that the fertilizer tests made by the agricultural experiment stations throughout the country have agreed in showing that soil acidity is almost always accompanied by a need of phosphatic fertilizer. They tested the fertilizer requirements of a large number of Wisconsin soils both in the field and in the plant house and the results confirm "the conclusion that acid soils need phosphates, and it will be possible, by a careful test of a soil with litmus paper, to tell if it needs, or will need in the immediate future, a phosphate fertilizer. * * *"

The litmus-paper test can be made in the field, if the soil is moist enough, by inserting a broad bladed knife into the ground and opening a slit wide enough to insert a rather long, narrow strip of litmus paper. With the knife blade the soil is pressed closely against the litmus paper and at the end of about three minutes the paper is carefully removed from the soil. If the paper shows red spots, the soil is acid. If the soil in the field is not moist enough for this test a small portion of it may be placed in a porcelain dish, moistened to the right consistency with distilled water and worked up with a knife blade. By pressing a piece of litmus paper between two portions of the soil with the knife blade and leaving it three minutes, acidity or nonacidity will be shown by the presence or absence of red spots. In every case, whether in the field or in the laboratory, care should be taken that the hands touch the soil as little as possible, because perspiration will turn blue litmus paper red, and lead to erroneous conclusions. The knife blade, the distilled water, and the porcelain dish should be tested to see that they are free from acid. * * *

The reason for this need of phosphates in acid soils may possibly be found in the fact that acids dissolve phosphate minerals, and soil acids, whether due to decomposition of organic matter in the case of peat or to long cultivation in the case of upland soils, will undoubtedly have a decided solvent action on phosphates in the soil, particularly on the calcium phosphates. When once in solution these phosphates are readily washed out by heavy rains. There is undoubtedly considerable phosphate material still remaining in acid soils, but it is at least unavailable to the plant, and it is possible that it may be a phosphate of iron or aluminum, such as dufrenite or wavellite, insoluble in weak acids. * * *

Soils not acid probably contain considerable calcium and magnesium carbonate which, going into solution as the bicarbonates in water charged with carbon dioxid serve to retain the phosphorus in the form of tricalcium phosphate, relatively insoluble in the soil moisture and yet soluble enough to supply the needs of the growing crop.

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[a] For an earlier paper on pure water see U. S. Dept. Agr., Farmers' Bul. 73, p. 3.

[b] Compiled from Wisconsin Sta. Rpt. 1906, p. 171.

PURE SEED VERSUS POOR SEED.[a]

The Kansas Station recently published a special circular comparing the cost of obtaining a full stand of alfalfa when pure and poor seed are used. Attention is called to the fact that in 1905 Kansas had an area of 1,018,206 acres devoted to cultivated forage crops, of which 602,560 acres was in alfalfa. The cost of seeding this alfalfa acreage at the rate of 15 pounds per acre with seed at 16 cents per pound, every single seed being good, would amount to $1,446,128, but taking as a basis from among the number of alfalfa seed samples analyzed by the station 28 showing an average of total impurities of 46.1 per cent and an average number of seed true to name but incapable of germinating of 34.5 per cent, it would have cost $1,935,042 to secure a full stand on the same area.

Letters from all portions of the State indicate that poor alfalfa seed is quite common. The principal impurities are dead and defective alfalfa seed itself, trefoil, English plantain or buckhorn, dodder, Russian thistle, crab grass, foxtail, and other weed seeds, and the adulterants often found are trefoil, bur clover, and sweet clover. It is pointed out that with good standard alfalfa seed, averaging 83 per cent of the seed true to name and capable of germinating, the cost of seeding an acre would be $2.40. This represents the actual cost of the 83 per cent of good seed, the 17 per cent being waste, and the real cost per bushel of viable seed is therefore about $12 instead of $10, at which the seed and the waste together was originally bought. In a certain sample of seed analyzed by the station only 20.2 per cent of the seeds were true to name and capable of germinating. A computation based on the cost of the standard seed shows that in order to obtain from the use of this poor seed as much of a stand as could have been secured with 15 pounds of the standard seed 73.9 pounds of this seed would have been necessary, and the actual cost of seeding an acre would have been brought up to $11.92, and the actual cost of the seed exclusive of the 79.8 per cent of waste to $49.26 per bushel. In addition to this prohibitive cost, the use of seed like this sample would have deposited on each acre over 4,000,000 weed seeds of various species, or 105 on each square foot. The use of seed represented by another sample studied would have raised the cost to $5.75 per acre, and would have sown this area with approximately 167,000 weeds of various sorts, including 95,000 plantain seed, 19,000 dodder seed, and 25,000 foxtail seed. Bad seed gives a weak, poor stand of alfalfa and a dense growth of weeds and wild grasses. In the 28 samples referred to above the impurities ranged from 21.6 to 100 per cent, the trash or dirt from

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[a] Compiled from Kansas Sta. Spec. Circ., January 30, 1907.

0.3 to 31.9 per cent, and the number of kinds of foreign seed present from 3 to 34.

These investigations with reference to bluegrass seed within the State show that Kentucky bluegrass seed is extensively adulterated with Canadian bluegrass seed, from which it is not distinguishable by the ordinary observer, especially when mixed with it. English bluegrass is very commonly adulterated with cheat, the seeds of the two plants resembling each other sufficiently to make adulteration easily possible. The quality of English bluegrass seed is frequently very poor, the germination in many cases not being above 40 per cent. A certain lot of this seed bought and sold in the fall of 1905 contained less than 50 per cent of germinable seeds, and the percentage of weed seeds was so high that on each acre there were sown with the English bluegrass seed 142,230 seeds of crab grass, 111,000 seeds of dock, 393,670 smartweed seeds, 62,340 cheat seeds, together with 111,000 miscellaneous seeds, making a grand total of 820,240 weed seeds of all kinds. The crop harvested contained only about 15 per cent of English bluegrass seed, while 79 per cent was cheat and the rest seeds of such weeds as bindweed, dock, foxtail, and pigweed.

The brome grass seed marketed in the State is also adulterated with cheat, and much of it has a percentage of germination of only about 40. A comparison of the different grades of seed as estimated and determined by the station is given in the following table:

The cost per acre of standard and poor seeds compared.

Samples.	Good seeds.	Seed required per acre.	Cost of seeding an acre.	Germinable seed, cost per bushel.	Weed seeds per acre.	Weeds per square foot.
	Per cent.	*Pounds.*				
Alfalfa 201	52.0	28.7	$4.63	$19.21	93,910	[illegible]
Alfalfa 20	73.6	20.3	3.07	13.58	238,750	[illegible]
Alfalfa 215	66.3	22.5	3.63	15.00	313,730	[illegible]
Alfalfa 227	42.0	35.7	5.75	23.80	167,470	
Alfalfa 267	20.3	73.9	11.92	49.26	4,241,950	[illegible]
Alfalfa standard	83.3	15.0	2.42	12.00	...	...
English bluegrass 284	49.3	105.4	1.05	4.05	820,240	...
English bluegrass 375	43.4	120.0	12.00	4.80	36,000	...
English bluegrass standard	80.7	50.0	5.00	2.47	...	...
Brome grass 107	49.5	50.0	3.85	3.00	157,000	...
Brome grass 229	32.4	77.0	8.25	4.65	207,900	...
Brome grass standard	67.5	25.0	2.68	2.38	...	...

It is believed that seed market conditions will not be improved without legislation, and it is pointed out that a law excluding from sale any seed with a percentage of germination below 76 would make a saving of at least 10 per cent each year, or of a total amount of nearly $22,000 on forage crops alone. A seed law proposed for the State requires a guaranty of 85 per cent of germination and imposes a tax of one-fifth of a cent on all seed packets less than 1 pound and of one-fifth of a cent per pound for all seed in bulk, and it is estimated that the operation of this law would save the State of Kansas 14 per cent net annually in cost of alfalfa seed and 25 per cent net in all other forage crops over and above the tax.

SELECTION FOR DISEASE-RESISTANT CLOVER.[a]

For a number of years the culture of red clover in Tennessee has been uncertain on account of a fungus disease which attacks the crop. In some parts of the State this disease has become so severe that clover growing has been practically abandoned. The disease has also appeared in Virginia, West Virginia, Kentucky, and Arkansas, and is found to occur on alfalfa as well as on red clover.

In 1905 Professors Bain and Essary, of the Tennessee Station, began to investigate this problem and found the trouble to be due to an undescribed fungus disease, a form of anthracnose. The fungus causing the disease belongs to the genus Colletotrichum, and was named *Colletotrichum trifolii.* The trouble occurs in new as well as in old fields of clover, but is usually the more severe where clover has been grown for some time. In many instances this disease almost entirely kills out a good stand in one season. As spraying methods, disinfection of seed, and methods of cultivation promised little toward finding a remedy, all efforts were concentrated on the production of a disease-resistant strain of clover by selection, and the results of the first year's work, which seemed very encouraging, are presented in a recent bulletin of the station.

During August and September of 1905, at which time most of the disease-infected clover had died, over 200 isolated healthy plants, having withstood the attack of the disease on badly infected fields, were selected and the seed of each individual plant kept separate. The seed was planted in rows 18 inches apart, and the select rows were alternated with ordinary commercial clover seed. On the land used for the purpose the disease had totally destroyed the clover crop in 1905, and in order that it might again prevail in 1906 the ground was only thoroughly disked, as it was thought that plowing would cover the germs too deeply. After the clover had been up five weeks a load ot dead clover raked up from a field destroyed by the fungus was scattered over the plat, putting practically every plant in direct contact with this infected material. On July 15 the dead and diseased plants from the nonselect rows were scattered over the selections as a further source of infection. Insect ravages reduced the number of plants to a considerable extent, but enough were saved to continue the experiment. Careful cultivation induced vigorous growth until June 1, when the plants from the commercial seed showed signs of the disease. By June 20 the unselected rows were blackened and dying, while the select rows alternating with them were almost perfectly healthy and normal. The entire plat had been mowed off between July 9 and September 14, in order to simulate actual cultural conditions.

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[a] Compiled from Tennessee Sta. Bul. 75.

It was estimated that of the select plants 95 per cent lived up to the end of this period, while of the nonselect plants not more than 5 per cent survived. While the selections nearly all made a fair average growth, many showed lesions of the disease by September 14, but a good crop of stems, leaves, and seed was obtained, and a satisfactory number of plants were exceptionally vigorous and without a trace of the anthracnose. A number of plants of both select and nonselect parentage died during the winter, but on the whole the selections were decidedly the more healthy in appearance. Basing the estimate on the percentage of surviving plants of each group to the approximate number of that group which germinated, the odds in favor of the selections appeared as 50 to 1.

The authors have found this disease on alsike clover in only one case, a seedling growing in the greenhouse. To study the life history of the fungus a number of flowerpots were seeded July 12 with red clover, alsike clover, and alfalfa. On July 22 these plants, after having made a vigorous growth for some days, became accidentally infected. The red clover and alfalfa seedlings succumbed rapidly to the disease, but the alsike clover seedlings proved immune. A few surviving plants of red clover and alfalfa were probably resistant to the disease.

The most important result of the above-described experiments is the striking indication of disease resistance shown by select individual red clover plants. Since every opportunity existed for the infection of the plants from select seed, and they were subjected to the most rigid test for susceptibility to disease, there is very strong indication, at least, that success will attend the effort being made to produce an anthracnose-resistant clover. The evidence may be briefly stated thus: Certain clover plants growing in 1905, surrounded by great numbers of other plants killed by anthracnose, produced offspring which, in turn, also resisted the disease alongside nonselect plants which were killed by the disease. Of course it remains to be seen whether the next and subsequent generations will likewise resist the disease.

ERADICATION OF WILD MUSTARD.[a]

Wild mustard is a well known and very widely distributed weed pest and one which it is very difficult to eradicate when once introduced. R. A. Moore and A. L. Stone, of the Wisconsin Experiment Station, have, however, been quite successful recently in destroying the weed in grain fields by spraying with a solution of iron sulphate.

The solution is made by emptying a hundred pound sack of iron sulphate into an ordinary 52-gallon cask (kerosene or vinegar barrels are gauged for approximately that amount) and then stirring until the sulphate goes into solution. Iron sulphate is in a granular form similar to that of salt or sugar and goes into solution readily. When stirred vigorously seven to ten minutes the sulphate is dissolved. Made in the proportions given, we found that the mixture was practically a 20 per cent solution, the proper strength, although some German experimenters have had good results by using a 15 per cent solution.

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[a] Compiled from Wisconsin Sta. Rpt. 1906, p. 259.

The solution was sprayed on an oat field badly infested with the weed when the plants were in the third or fourth leaf. The results show that in all cases practically all of the weeds were destroyed.

The spraying should be done on a calm, bright day, after the dew has disappeared, as the work is more effective if the solution is put on in the warm sunlight. When rain follows the spraying within a few hours the extermination of the mustard will not be complete.

The grain fields should be sprayed when the mustard plants are in the third leaf, or before the plants are in blossom, in order to have the spray do the most effective work. The day following the spraying the tips of the blades of grain may be somewhat blackened, but no detrimental effects can be noticed, either to the crop or grasses seeded with it, two weeks after spraying.

Daisies, cocklebur, bindweed, ragweed, chicory, sheep sorrel, yellow dock, wild lettuce, and many other weeds were partially or wholly eradicated from the fields where tests were made for the extermination of mustard.

Iron sulphate can be purchased for about $11 per ton in small quantities and in bulk for considerably less. One hundred pounds of iron sulphate will make sufficient solution of the proper strength to spray approximately 1 acre. From 20 to 25 acres of land can be covered in a day where the sprayer is kept in continual use.

The iron sulphate solution is not poisonous and can be readily handled without injury. White clothing coming in contact with it will be discolored, but not burned.

STERILIZATION OF SOILS FOR THE PREVENTION OF DISEASES OF PLANTS.[a]

Growers of lettuce, cucumbers, tomatoes, carnations, violets, and other plants under glass and of plants in seed beds often find the plants suddenly dying while their foliage seems to be fresh and vigorous. This is especially true of plants in their seedling stage, and a careful examination will show that they are affected at or below the surface of the soil. The causes of the trouble are certain soil fungi and minute worms, called eelworms or nematodes. Where it is possible to renew the soil in the beds every season comparatively little loss will be met with, provided the soil is not infested when put in the beds. When the same soil is used season after season it is likely to become so filled with fungi and nematodes that the production of healthy, stocky plants will be impossible. The fungi, which are usually sterile, are present as minute threads or mycelia and the nematodes as active worms or as eggs and encysted or dormant forms. The fungi enter the plant through the roots and cause various forms of drop, wilt, and rot, while the nematodes cause galls on the roots and thus interfere with their function as absorbers and conveyors of water and mineral matter to the plant.

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[a] Compiled from Connecticut State Sta. Rpt. 1897, p. 310; Massachusetts Sta. Bul. 55; Rpts. 1898, p. 149; 1899, p. 59; 1901, p. 74; 1902, p. 38; 1904, p. 10; Ohio Sta. Bul. 73, Circs. 57 and 59. For previous articles on this subject see U. S. Dept. Agr., Farmers' Buls. 186, p. 8, and 259, p. 9.

Drying and freezing have comparatively little effect upon these parasites and spraying the foliage with fungicides will be of no value, since it does not reach the seat of the trouble. Fortunately it is possible to almost wholly prevent the injury due to these parasites by the sterilization of the soil, either by heat or by chemical treatment. The old practice of burning brush and other material over the site of the tobacco seed beds unconsciously secured sterilization, although by many the benefit was attributed to the presence of the ashes. Heating the soil in any way, provided it is thoroughly done, will destroy fungi and nematodes. Dry heating and burning are not always convenient or advisable, but sterilization by the application of steam is entirely practicable. This can be done in boxes especially designed for the purpose or may be effected by leading perforated steam pipes through the beds.

The box method is fully described by G. E. Stone, of the Massachusetts Station, and W. E. Britton, of the Connecticut State Station, and consists essentially of tight zinc-lined boxes into which steam can be admitted under pressure, and the soil is held in shallow trays with galvanized-iron netting bottoms. Space is allowed between and around the trays, and an exposure of one hour to steam will destroy all nematodes and most fungi and their spores as well as any weed seed that may be in the soil. After exposure to the steam the soil can be spread in the beds and seeded as soon as convenient.

Doctor Stone and others have shown that as a rule seed germinates more quickly and plants develop better in sterilized than in unsterilized soil. The reason for this was studied by Schulze[a], a German investigator, who found that while during sterilization there were formed some decomposition products which are injurious to a certain extent for a time, these disappear after the lapse of a few days or are corrected by the addition of a small quantity of lime, and there was always an increase in the amount of available nitrogen present in sterilized soil due to the action of heat on the soil compounds, so that while the growth in sterilized soil may be retarded for a short time the plants ultimately become more vigorous and the total growth is decidedly greater in sterilized soils.

Where benches are prepared with tile for subirrigation the steam can be led into the tile and the expense of sterilization will be nominal. Where the soil is treated with steam passed through perforated iron pipes the cost of sterilization has been estimated at about $8 per 1,000 cubic feet of soil. By better apparatus the cost could be reduced to about $2 per 1,000 cubic feet.

Where steam is not available it has been found that certain chemicals injected into the soil will aid in sterilizing it. A. D. Selby, of the Ohio Station, has found that formalin or formaldehyde applied to the soil in a strength of 2 pints of formalin to 50 gallons of water is quite efficient for the destruction of fungi and active nematodes, although it does not destroy the nematode eggs or encysted forms. For these steaming is best. To treat soil with formalin it should be prepared as for seeding, and after being well raked and in a friable condition it is drenched with the solution as given above at the rate of about 1 gallon per square foot of surface. A bed 50 feet long by 6 feet wide would require about 300 gallons of the mixture containing from 12 to 15 pints of formalin. This would cost from $1.80 to $2.25 in carboy lots. If applied to seed beds in the fall before freezing weather sets in this treatment will keep down all forms of rot, damping off, and similar plant diseases.

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[a] Landw. Vers. Stat., 65 (1906), No. 1-2, pp. 137-147.

PRODUCTION OF SEEDLESS TOMATOES.[a]

The production of any vegetable novelty always arouses interest among seed growers and gardeners. More or less of this work has been done by the experiment stations. For a number of years breeding experiments with vegetables have been carried on by Professor Halsted and his associates at the New Jersey stations. Among the distinct and valuable productions secured in this work is a nearly seedless tomato. As is well known, each fruit of the ordinary tomato contains hundreds of seeds, while the form which Professor Halsted has developed seldom contains more than fifty seeds and frequently there are not more than five or six and often none.

This variety has become pretty well established now and has been called the Giant because of the very large size that the plant attains. It originated five or six years ago as a result of a cross of Golden Sunrise upon Dwarf Champion.

> The seedlings frequently bear three cotyledons, and the plants are very slow, growing long stemmed, with the foliage open, due to the long internodes, and leaves with the divisions widely separated, which are crinkled, and the terminal leaflet blunt pointed. The flower clusters are small, flowers cup shaped, light lemon yellow, and the fruits few, medium small, light yellow, and nearly seedless. The flesh is particularly fine flavored. The plants, 3 feet apart each way, covered the ground devoted to the block, and flowered up to the killing frosts near November 1.

The type appears to be well fixed. Attempts to cross other sorts upon it have uniformly failed.

Seedless fruits have also been produced by Professor Halsted on several varieties and crosses of tomatoes, due probably primarily to nonpollination with other conditions favorable to the stimulation of fruit production. These crosses were quite uniformly dwarfed in size, many in a cluster being not larger than peas, but solid fleshed, and often of good quality. In one instance the fruit had the flavor of the strawberry. Currant crossed upon Stone produced such fruit, likewise Crimson Cushion upon Sumatra. When Crimson Cushion was crossed upon Giant and Magnus many seedless fruits were produced, some of which were large enough for table use. Cuttings taken from plants which produced numerous seedless fruits of this sort when planted out in the garden gave only normal fruits.

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[a] Compiled from New Jersey Stas. Rpts. 1901, p. 442; 1903, p. 492; 1904, p. 491; 1905, p. 468; Wisconsin Sta. Rpt., 1905, p. 300.

E. P. Sandsten, working at the Wisconsin Station, produced seedless tomatoes by an entirely different method, i. e., the use of excessive amounts of fertilizers. He worked in the greenhouse with a good potting soil, using commercial fertilizers at the rate of 800 pounds of nitrate of soda, 600 pounds of sulphate of potash, and 1,000 pounds of desiccated bone per acre. Many abnormalities in the growth of the plants and fruit were observed. "In almost all cases there was a tendency of the plants to produce fruits containing a much smaller number of seeds than is generally found in the ordinary fruit." In one instance the plant was dwarfed and the fruit not larger than a walnut, but firm fleshed and entirely seedless. Another plant produced a large solid fruit that was seedless. Cuttings taken from these plants and set outdoors remained true to type, but produced more and larger fruit than in the greenhouse.

We thus have at least two ways of securing seedlessness in tomatoes—by crossing and selection and by high feeding with fertilizers. The work with seedless tomatoes at both these stations is being continued and promises to result in the establishment of varieties with far less seeds in than the sorts commonly grown. It brings out strikingly the variations that may occur in plants as a result of crossing and high feeding with fertilizers.

PICKLING OLIVES AND MOCK OLIVES FOR HOME USE.[a]

In California, Arizona, and other States where olives can be grown successfully many housewives are interested in pickling them by household methods for home use. According to experiments carried on at the Arizona Station by W. W. Skinner this can be successfully done.

The two varieties which have given the best results in home pickling are the Mission and Manzanillo. "The Mission holds its color well while being pickled, and with reasonable care in the extracting process yields a product which is firm and of good flavor. The Manzanillo is superior to the Mission in flavor, but the fruit is of a finer texture and is prone to soften during treatment; nor is the color of the finished product so good as the Mission."

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[a] Compiled from Arizona Sta. Bul. 51, California Cir. 24, Wisconsin Sta. Bul. 136. See also U. S. Dept. Agr., Farmers' Bul. 122, p. 16.

The olives, either green or ripe, should be picked into pails about one-third full of water, to prevent bruising, and sorted as to size and ripeness. The fruit is then placed in suitable vessels (preferably stone jars, though wooden kegs, etc., may be used if sterilized so that they are free from mold spores), the water poured off, and the fruit covered with a solution made of 2 ounces of soda lye, 1 ounce of lime, and 1 ounce of common salt to a gallon of water. The solution should be thoroughly mixed and allowed to stand an hour before using, and is best if made of boiled and cooled water. It should stand about 2 inches above the fruit, and if any of the olives float it is necessary to cover them with a board and weight.

The time of the lye treatment varies from three to seven days, according to the variety, size, and ripeness of the fruit. The solution should be examined daily, and should the sleek, soapy feeling peculiar to lye disappear, it indicates that the solution is exhausted. The old solution should therefore be poured off and new solution added. It should also be changed at once should any scum or mold appear. The fruit should be frequently examined, always sampling the largest olives by cutting away a portion with a sharp knife. The progress of the lye toward the interior of the fruit is plainly marked by a distinct dark ring. When the ring has reached almost but not quite to the pit, it is time to remove the lye and commence the washing.

The lye should now be poured off and water added and renewed morning and night. The wash water should also be boiled as a preventive of mold, which is very likely to develop at this stage of the pickling process. The fruit should be kept in water, as before, with the board and weight, and throughout the extraction, washing, and salting the vessel should be closely covered. It will require from four to seven days to remove all traces of the alkali. Washing should be continued as long as the fruit has the peculiar hot taste due to the presence of lye, and it is well to test it with red litmus paper, which will turn blue if a trace of the lye remains. If the olives are still bitter after the washing has been completed, they should receive a second treatment with lye, followed by washing.

When free from lye the olives are ready for salting, the brine being composed of 2 ounces of common salt to a gallon of water. It should be thoroughly boiled, cooled, and poured over the olives. The next day this solution should be poured off and a solution containing 4 ounces of salt should be used. "If the stronger solution is used to begin with, the olives will shrivel. The fruit should next be treated with an 8-ounce brine, and if intended to keep for some time, finally with a brine containing 14 ounces of salt to the gallon. A 14-ounce brine, however, makes the olives too salty to be used without a slight soaking."

In the author's opinion, a better method of keeping the finished product is to process the olives after adding the 8-ounce brine. Glass fruit jars filled with olives and brine, with the covers lightly screwed down over the rubbers, are stood in water in a tin wash boiler and heated to 175° F. for thirty minutes. They should be then removed and the covers quickly tightened. "By this process the flavor of the olive is not injured, and if properly done the fruit will keep at least several months without deteriorating."

Mrs. L. H. Adams and E. P. Sandsten, of the Wisconsin Experiment Station, in a recent bulletin state that mock olives can be made for home use from unripe plums. According to the directions which they give, the plums when just beginning to ripen, but still green, should be pickled in a brine strong enough to hold up an egg; the brine may be made from sea salt, or, if this is not convenient, from common rock salt. The brine should be poured, hot, over the fruit and allowed to stand for twenty-four hours. It should then be poured off and the fruit placed in a new brine, boiled for one minute, and sealed in the hot brine in suitable jars.

THE HAY BOX OR FIRELESS COOKER.[a]

Considerable interest has been manifested recently in a system of cookery in practice in Norway and other parts of Europe, in which boiling hot food in tightly covered receptacles is packed in some nonconducting material in such a way that it keeps hot for a long time and slowly cooks. As hay is commonly used in Europe as a packing, the cooker is frequently called a "hay box cooker." Sometimes it is spoken of as a "Norwegian nest," and the name "fireless cooker" is also used. The principle involved is a simple one, namely, the retention of heat and hence the continuation of cooking by surrounding hot food with some nonconducting material.

Just when the Norwegian cooking apparatus was devised it would be hard to say, but it has been in use for a long time and in 1867 excited considerable interest and curiosity when it was shown as a part of the Scandinavian exhibit at the Paris Exposition. W. Mattieu Williams[b] describes it in his treatise on cooking, first published a number of years ago, as being well known, and also makes reference to an experiment of Count Rumford's in which meat was cooked under similar conditions—that is, by keeping it for a long time at a temperature somewhat lower than that of boiling water. Many persons are doubtless familiar with Williams's own experiments in which eggs were cooked in a fireless cooker. The eggs were placed in an earthen vessel filled with hot water, which was then tightly covered, wrapped in flannel, packed in a padded hat box, and allowed to remain overnight. In the morning they were found, he says, to be "cooked to perfection."

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[a] Compiled from Cornell Reading Course for Farmers' Wives, 5. ser., 1907, No. 23, p. 446; Rept. Commis. Gen. [U. S. Army], 1905, p. 80; 1906, p. 14.

[b] Chemistry of Cookery, 1885, pp. 23, 29, 30.

According to Williams's description, the Norwegian cooking apparatus "consists of an inner tin pot with well-fitting lid, which fits into a box, having a thick lining of ill-conducting material—such as felt, wool, or sawdust (it should be 2 or 3 inches thick, bottom and sides). A fowl, for example, is put into the tin, which is then filled up with boiling water and covered with a close-fitting cover lined like the box, and firmly strapped down. This may be left for ten or twelve hours, when the fowl will be found most delicately cooked."

From time to time articles have appeared regarding this method of preparing food, and recently considerable interest has been manifested in the subject, perhaps owing to the efforts of the German Government[a] to direct the attention of the families of small means to this device as furnishing an economical method of cookery. The popular descriptions[b] of this sort of cooker, which have appeared now and then, differ more or less in details, but the principle is always the same, namely, the retention of heat by surrounding the food with nonconducting material.

Such cookers may be readily made at home, and even when they are of very simple construction they have given good results provided they are well packed with insulating material. A tightly covered tin or enameled can or bucket or a kettle preferably without a handle, but having a tight cover, and a wooden box and packing material are the essential features. The packing box or other receptacle should be considerably larger, say 3 or 4 inches in every direction, than the vessel used for cooking. Line the box with several thicknesses of paper or with asbestos. Over the bottom of the box should be spread a thick layer of hay, crumpled newspaper, or similar material tightly packed. The cooking vessel is placed on the center of this and the spaces between it and the sides of the box packed full of the hay or whatever is used. A thick cushion or pad of suitable size should be made for covering the top of the can and a wooden cover for the box is also desirable. In some of the cookers which have been described in magazines, etc., thick felt, asbestos, cork, and other nonconducting materials have been used for packing, but good results have been reported with the simpler materials.

These cookers may be made to hold one or more cooking vessels, and in case space is desired for two or more it is convenient to divide the box into compartments.

Figure 1, which is drawn from data furnished by tests carried on at the Cornell Agricultural College and Experiment Station, in connection with home economics courses, shows a cooker suitable for two cans.

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[a] Mo. Consular and Trade Rpts. [U. S.], 1905, Nos. 297, p. 15; 302, p. 242.

[b] Home Sci. Mag., 20 (1903), p. 9; Amer. Agr., 79 (1907), No. 1, p. 27; Everyday Housekeeping, 22 (1906), p. 816; The Hay-Box Cook Book, Chicago, 1906.

The tests at Cornell have been satisfactory and the hay box cooker "is recommended to housewives as a means of saving fuel and securing good results in cooking cereals, chicken, macaroni, or anything requiring long, slow cooking or steaming."

The food which is to be cooked is brought to the boiling point in the can or bucket and cooked for a short time, two or three to twenty minutes usually, or perhaps ten minutes on an average (though the time depends upon the material and should be learned by experience), and is tightly covered and placed in the nest and covered on top with the cushion and the lid of the box closed. The cool air of the room can not pass through the packing to the can nor can the heat inside it pass through the nonconducting material, except very slowly, and so the food remains hot for several hours and cooks thoroughly and evenly without further attention. According to the Cornell report, "about twice as much time is required as in cooking over the flame. There is little evaporation. Consequently, care must be taken not to use too much water in preparation. Many articles of food are better for long, slow cooking, and as neither fire nor attention is needed (after the initial heating) it proves an economical means of preparing food for the table." An advantage claimed for the hay box cooker is that there are no noticeable odors from the cooking food.

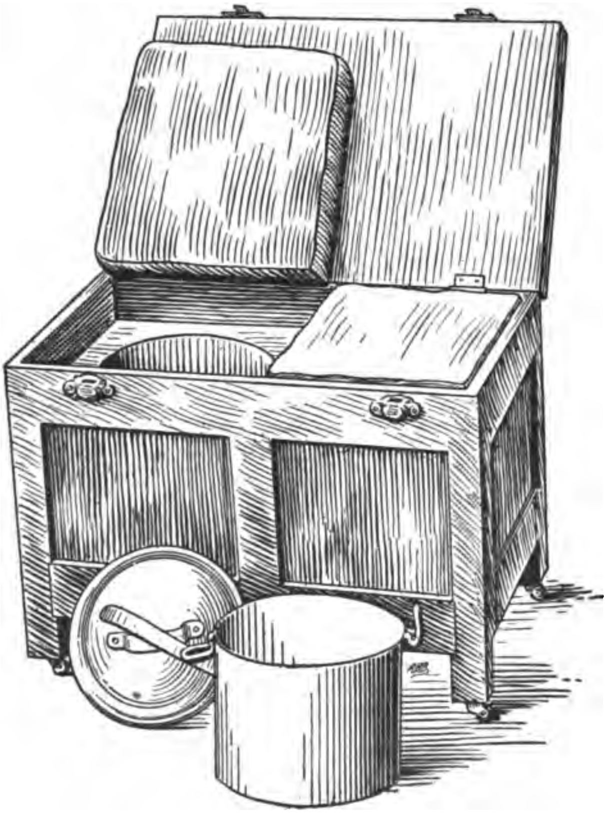

FIG. 1.—Hay box or fireless cooker.

The cooker must not be opened from the time the food is placed in it until it is needed for serving, as the removal of the covering, etc., would mean an escape of heat.

Cookers constructed on the principle outlined have been tested for several years by the Commissary Department of the United States Army and have given good satisfaction, particularly for the preparation of rations for soldiers on the march. According to the reports of the Commissary-General, the cookers used are of large size and special attention is given to packing materials and other factors so as to insure the insulation of the containers in which the food is cooked. The meat, beans, cereal, or other food is heated in the can at breakfast time, packed, and carried in carts with the other camp equipment while the men are on the march, and when camp is reached at night a hot soup or other dish is ready without the delay attendant on cooking a hot meal in the usual way.

In this system of cookery the food is kept on the stove for only a short time, and hence only a small amount of fuel is required, and it has a further advantage in that it does not heat the rooms in which the cooking is done.

By means of this cooker a breakfast cereal may be prepared by boiling it a few minutes in the evening, then packing it away in the cooker, and in the morning it will be ready for use. Soup can be prepared early in the day and will be ready for luncheon without any further attention. In the descriptions of the hay box cited above and other similar publications the writers, on the basis of personal experience, give directions for the preparation of vegetables, meats, soups, desserts, and other dishes, and the consensus of opinion seems to be that the hay box cooker is a convenient. economical, and labor-saving device.

COMBATING INSECT ENEMIES OF SHADE TREES.[a]

In recent years more and more attention has been given by municipal authorities to the condition of shade trees within the city limits. A number of insect pests of prime importance have attacked trees used for shade purposes in cities, and where no attention has been given to these pests they have often completely defoliated even the largest shade trees along the streets and in city parks.

At first it was considered difficult, if not impossible, to apply direct insecticide treatment to tall elms and other shade trees. Prof. J. B. Smith, of the New Jersey Station, however, showed that if a strong barrel pump were used and a bamboo extension pole attached to the hose for holding the nozzle as far as possible from the ground, trees of moderate size could be readily sprayed with insecticides. Since that time various power sprayers have been put in operation by means of which sprays may be thrown to the top of the tallest shade trees. Since the most serious shade-tree insects feed upon the foliage and may, therefore, be destroyed by the use of arsenicals, it becomes merely a matter of civic pride whether suitable means will be put in operation for protecting shade trees. It has been estimated by Doctor Howard that with an expense of $4,000 or $5,000 annually almost any city in the United States may keep the foliage of its shade trees in a green condition throughout the growing season.

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[a] Compiled from Illinois Sta. Bul. 112; Kentucky Sta. Bul. 120; Massachusetts Sta. Bul. 114; New Hampshire Sta. Bul. 128; New York Cornell Sta. Bul. 233; U. S. Dept. Agr., Farmers' Bul. 99.

Great differences have been noted in the susceptibility of various species of shade trees to insect attacks. The least susceptible is the ginkgo, which in this country has not been attacked by any serious insect pest. The tulip tree is almost equally free from insects, although plant lice and gall midges may disfigure the leaves to some extent. It is not practicable, however, to plant in all cities only those trees which are free from insect pests. Strong preferences are held by the citizens of different municipalities for elms, maples, lindens, and other well-known shade trees which are more or less seriously attacked by insects. In order to protect their foliage from destruction during the growing season it is necessary, according to the experience already had in various cities, to place the work of insect control on shade trees in the hands of a city forester or superintendent of parks.

Among the most serious insect enemies of shade trees are the elm leaf-beetle, tussock moth, bagworm, fall webworm, brown-tail moth, gipsy moth, cottonwood leaf-beetle, and cottony maple scale. Recently the oriental moth has been discovered in Boston and threatens injury to shade trees. All of these insects except the cottony maple scale may be destroyed by spraying the foliage with arsenicals, especially arsenate of lead. The first application may be made immediately after the buds have opened and further treatment may be regulated according to the abundance of leaf-eating insects in any given locality. Most of the pests mentioned in the list of important shade-tree insects are open to other methods of attack. Thus, the winter nests of the brown-tail moth should be destroyed before the insects become scattered in the spring. The gipsy moth may be captured by banding the trees and its numbers will be greatly reduced by destroying the egg masses. The elm leaf-beetle in the larval condition may be destroyed about the base of the trees by spraying with kerosene emulsion. The egg clusters of the tussock moth are conspicuous and may be easily removed and destroyed.

Serious outbreaks of cottony maple scale have been reported during the last two or three years in Chicago and other cities. This pest must be controlled with contact insecticides, among which kerosene emulsion has given the best results. The cottony maple scale attacks chiefly the soft maple, linden, box elder, elm, and honey locust. In a series of experiments carried out by Professor Forbes, of the Illinois Experiment Station, it was found that the most useful insecticide for the control of this pest was kerosene emulsion, which, if applied in summer, should not contain more than 10 to 12 per cent of kerosene, and if used in winter not more than 16 to 18 per cent. It is recommended that the first summer application be made when about half of the eggs are hatched and the second just at the end of the hatching period. As a rule, however, a thorough winter application of the stronger kerosene emulsion is more effective than the summer treatment.

FEEDING WHOLE GRAIN.[a]

In ordinary digestion experiments with farm animals the proportions of nutritive materials remaining in the feces are determined by chemical analysis, and such data are of course admirably adapted for the study of many problems.

A mechanical method of separating the undigested from the digested material is sometimes followed in the study of various practical questions connected with animal feeding. It is customary in such tests to mix the manure with large quantities of water, which washes away the metabolic products and similar materials and leaves the undigested grain behind. The fact that the manure may contain considerable undigested material receives practical recognition in animal feeding. Pigs are very commonly allowed to follow fattening steers in order that they may gather and utilize this food which would otherwise be wasted.

In tests undertaken at the Kansas Station to determine the relative amounts of soaked and dry corn thus available for pig feeding, the droppings from two lots of steers were gathered for twenty-eight days. The undigested corn was carefully washed out from the feces and weighed and it was found that the steers fed the soaked corn failed to digest 11 per cent of the 3,045 pounds eaten and those ed the dry corn 16 per cent of the 3,060 pounds eaten. The grains compared in a later test at the Kansas Station, which covered thirty-three days, included corn meal, red Kafir corn meal, and white Kafir corn meal. Washing away the digested material from the undigested showed that 5.5 per cent of the corn meal, 11.3 per cent of the red Kafir corn meal, and 14.1 per cent of the white Kafir corn meal passed through the animals undigested. The utilization of the undigested material by pigs was one of the principal features studied n both of these tests.

A recently published bulletin of the Michigan Station reports the esults of a study undertaken to determine the proportion of whole corn, whole oats, and a mixture of these grains which escaped digestion when fed to cattle. According to R. S. Shaw and H. W. Norton, jr., who carried on this work—

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[a] Compiled from Kansas Sta. Buls. 47 and 67; Michigan Sta. Bul. 242.

> For some time past the system of feeding whole grain has had many advocates. Some speakers and writers on agricultural and live-stock subjects have advised the use of whole corn either alone or in conjunction with other grains for steer feeding, and many farmers are feeding whole oats to cows, young stock, and calves.
>
> The presence of large quantities of oats in the droppings from cows fed a grain mixture containing whole oats, and the fact that a field manured with these droppings produced a fairly good stand of oats suggested an experiment to determine the percentage of whole grain passing through the digestive tract. * * *
>
> Claims are also made by advocates of this method of feeding that even though a large amount does pass through without apparent change still the animal "gets a l of good out of it." To clear up this last question chemical analyses were made to fin the exact composition of the grain both before and after feeding in order to detect a changes taking place. * * *
>
> No attempt was made to compare the feeding value of whole grain with groun grain, nor was any attempt made to ascertain the gains or losses in weight made b the animals while on the whole-grain feed.

Each of the grain rations was tested with lots containing two cows, two heifers, and two calves, the feeding period covering seven days.

> All grain fed was weighed and all droppings collected and washed through scre to separate the grain. The screens were as fine meshed as could be used and st allow the escape of everything but the grain; in fact some of the oats were wash through and lost. * * * The grain was then spread out in a warm room and dri and run through a fanning mill to clear from straw and chaff and was finally weigh. Samples were taken for chemical analyses.

The following table shows the proportion of the grain eaten whic was recovered whole in the feces:

Proportion of grain eaten recovered whole in the feces; experiments with cattle.

Kind of animal.	Whole corn recovered.	Whole oats recovered.	Whole c and oats recovere
	Per cent.	*Per cent.*	*Per ce*
Cows	22.75	12.06	[illegible]
Heifers	10.77	5.48	[illegible]
Calves	6.28	2.98	[illegible]

It will be noted that in every case smaller quantities of undigeste grain were found in the droppings of the younger animals and tha the proportion of corn which escaped digestion was greater than tha of oats.

> Chemical analyses showed practically the same composition of grain as before fe ing; therefore it is safe to conclude that the animal derives no benefit from grain wh passes through the digestive tract unmasticated.
>
> The germinating power of the grain passing through the system was affected ve markedly but not entirely destroyed, as 4.3 per cent of the corn and 10.6 per cent the oats germinated after this treatment.

The data reported are not sufficient for general deductions as t the relative merits of whole and ground grain or soaked and dr grain, but they do clearly show that in ordinary methods of feeding the proportion of grain which escapes digestion may be considerable. It is a matter of experience that cattle fed large grain rations toward the close of a fattening period digest such feed less completely than animals eating smaller quantities. Factors like the above should receive consideration in regulating the number of pigs following fattening steers and other questions connected with animal feeding, n order that the greatest profits may be secured.

The length of time which grain remains in the digestive tract was one of the questions considered in the tests at the Kansas Station. On one day of a feeding period red Kafir corn was substituted for the white Kafir corn which made up the grain portion of the ration. On the day immediately following it was found that red kernels began to appear in the manure and the maximum number was noted on the afternoon of the second day. They then began to decrease, and on the fourth day only a few red kernels were found in the washings.

THE IMPROVEMENT OF CATTLE.[a]

The Michigan Experiment Station has begun animal-breeding experiments, and a recently published general discussion of breeding problems by R. S. Shaw is the outcome of this work. In Professor Shaw's opinion very many Michigan cattle breeders raise inferior milch cows and steers, the chief fault of the common cattle being a ack of quality and uniformity, which is due not so much to lack of he infusion of good blood as to the indiscriminate admixture of beef and dairy types.

> With the rise in prices of dairy products, the common cows have been bred to dairy bulls; with depreciated values for dairy products, these same cows and their female progeny have been bred back to beef sires, and so on. On the other hand, there are plenty of instances where herds possessed of cows of a small type, producing a small low of rich milk, have been bred to a bull of a larger breed noted for heavy milk low, and vice versa.

In urging that widespread attention be paid by Michigan cattle aisers to improvements in dairy and beef herds, a number of general deductions are drawn regarding some of the more important phases of cattle breeding. In the author's opinion live stock improvement s not difficult.

> Questions of breeding are generally regarded as being obscure, intricate, and xtremely difficult, except to those skilled in the art through long years of training. * * But the initial step in live-stock breeding for improvement confronting us to-day is an exceedingly simple one; we do not need to undertake the establishment of new types or breeds, as there are plenty now in existence to choose from which, judiciously chosen, will respond favorably to the conditions to which they are dapted. The first step in the line of live-stock improvement must come from the cessation of the practice of admixing the blood of the various breeds and of using grade nd scrub sires.

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[a] Compiled from Michigan Sta. Bul. 241.

The plan we have to suggest [for the upgrading of herds] and discuss for the improvement of the common stocks of the country is that known as upgrading, which consists in ingrafting the characteristics of a superior breed upon animals of common or mixed breeding for the purpose of improving them. This improvement is due to the superior quality of the males used and chiefly their prepotency or power of transmitting accurately these qualities to their offspring. This plan differs from crossbreeding in that pure blood is used on the sire's side and females of mixed blood or no blood on the dam's side. Thus we have the prepotency concentrated in the bull and the very opposite in the females, as the more mixed the breeding the less stable are the inherent characteristics of the individual, and therefore the less resistant to improvement.

It would be absolutely impracticable to advise all owners of common cattle to send their stocks to the block and purchase pure-bred foundation stocks; only a few could do this for the following reasons: First, if the great majority now possessed of common stocks were to simultaneously seek to purchase pure-bred foundation stocks, they could not get them; they are not in existence, for only about 1 per cent of the cattle in the United States are possessed of pedigrees. Second, the finances of a great many holders of common stock are not such as to allow them to make extensive purchases of pedigreed animals and replacement is out of the question, as it would require the returns from the sale of three or four common animals to purchase one pedigreed one. Third, it is highly desirable for breeders to grow into any line of pure breeding rather than to buy into it suddenly and take up a work in which experience is necessary.

In general, then, it is necessary for the majority of holders of common stock to make the best use of the animals on hand with a view to improving them. Let us suppose the case of a herd of common or mixed cattle of, say, 18 head and apply a plan of improvement. The first thing for the owner of this herd to do is to decide upon some one line of production, either beef or dairy, and then stand by the resolution. Without this he can not improve his herd, for the animals of mixed breeding are largely the result of frequent change of purpose. Suppose in this case that the owner has decided to go into the dairy business; that being the case, the next thing to do will be to look over the herd of 18 and decide which ones are so possessed of dairy type and characteristics as to warrant their being used in the business. They can be divided into three classes—such as best, medium, and inferior—from a dairy standpoint. Then, in the majority of cases, it will be found to be a decided advantage to send the 6 inferior ones to the block and use the remaining 12 for the foundation herd. Having selected the females to be retained, the next and one of the most important steps is to decide upon the breed to be used in improvement. In this adaptability of the breed to the conditions and the question of personal preference are the two important factors; the decision of this question is also an important factor, for a change of mind after the work has begun and the use of other blood is more apt to result in retrogression for a time than improvement. Having decided upon the breed to be used for improvement, suppose it is the Holstein, then purchase the best Holstein bull that the pocketbook will allow. Mate this bull with the 12 selected cows and use him for two seasons, after which his progeny will be old enough to breed. At this point secure another Holstein bull, a better one than the first if possible; follow him with others of the same breed indefinitely. Let it be Holstein bull after Holstein bull, nothing but Holstein bulls. We have cited the Holstein merely for the purpose of this illustration. The same plan must be used no matter what the breed is. * * *

We desire at this point to emphasize the fact that the use of improved methods of breeding alone will not avail. It is absolutely necessary for these to be supplemented by liberal feeding and proper care and management.

The maturity of animals has an important bearing on their value for breeding purposes.

In general, it can scarcely be said of a bull that he has reached full maturity until 4 years of age, though this perfect stage of development is commonly regarded as being attained at a somewhat earlier age among some breeds. It has been a common practice for years among farmers to send the 3 or 4 year old bulls to the block, largely because there is no sale for them as breeders. The general rule among prospective purchasers is to search for nothing but young bulls—yearlings or less—with the idea that they will grow into money for them, if they can dispose of them before maturity. * * *

There are some decided advantages in purchasing mature bulls. One of the greatest of these is found in the fact that the buyer can ascertain something relative to the character of their get. This is most important to the breeder of dairy stock. Another advantage arises from the fact that there is always more or less uncertainty regarding the future development of the bull calf, while this factor is entirely eliminated in the purchase of a mature sire. It is also not unreasonable to conclude that a mature sire will beget more vigorous offspring, especially because the young ones are frequently used to excess. Three and 4 year old bulls can generally be secured at very reasonable prices.

During the past decade or two there has been a growing tendency to breed heifers at an early age. This is particularly true among the dairy breeds. * * *

While it is clearly apparent that immature breeding has reduced the size of many of our dairy cattle, it has not been proven that diminished constitutional vigor has accompanied this loss of size, though many hold to that view. It is rational to assume that in unduly immature breeding some of the physiological laws of nature must be violated, and this can not occur without being followed by some evil results. No fixed age can be given for the breeding of heifers. It should be dependent on the rapidity and character of the development of the individual.

As regards grades versus pure breeds, "high-grade animals may be eventually produced capable of equaling those of the pure breed used in their improvement in so far as meat or milk production are concerned, but at the same time they can never equal them in prepotency nor become possessed of pedigrees, except in rare instances."

In breeding up herds some form of cooperation, in Professor Shaw's opinion, should be established by communities, such as the joint ownership and use of males by several cattle breeders. That such cooperation has not always been successful when attempted is explainable on several grounds, but there is every reason, in his judgment, to believe that it is possible and, rightly managed, will lead to satisfactory results.

VENTILATION OF STABLES.[a]

Some experiment station work along the line of stable ventilation has been summarized in a previous bulletin of this series.[b] Many problems have arisen in connection with the ventilation of stables and have assumed such importance that the necessity for the study of the subject from all possible standpoints has been recognized. Important contributions to the subject have recently been made by M. H. Reynolds, of the Minnesota Station. The results obtained by this investigator appear to be at variance with the commonly accepted ideas of ventilation and suggest that new explanations are needed of the observed facts in cases of good and poor ventilation.

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[a] Compiled from Minnesota Sta. Bul. 98; U. S. Dept. Agr. Yearbook 1904, pp. 216–218.

[b] U. S. Dept. Agr., Farmers' Bul. 190, p. 23.

One of the main objects of this study was to determine the effect of carbon dioxid upon animals confined in stables. In experiments with human beings in the respiration calorimeter Professor Atwater has shown that man remains apparently in perfect comfort in an atmosphere containing 2.3 per cent of carbon dioxid, or almost 80 times the quantity found in ordinary atmospheric air. The air, however, was kept pure in other respects and the amount of moisture was not unusually high. In the experiments carried out by Doctor Reynolds on cattle the air was saturated with moisture and the amount of carbon dioxid varied, being in some cases as high as 2.67 per cent, as compared with 0.03 per cent in ordinary air. Moreover, the air contained ammonia and other organic materials which may be given off in expired air.

In such an atmosphere, obtained by confining steers in a nearly air-tight box stall, steers were kept for periods varying from two to twenty-eight days. None of the bodily functions were materially disturbed, the only effects observed being a slight increase in the rate of pulse and respiration and a small elevation of temperature. The animals showed good appetite and appeared to be in perfect health and comfort during confinement. The amount of moisture in the atmosphere of the stall was so great that water ran down the sides of the stall and the walls became covered with mold. Nevertheless, animals confined under these circumstances not only appeared to remain healthy and comfortable, but gained at the rate of 1 pound per day. Even the healing process following upon dehorning seemed not to be interfered with by confinement in the moist atmosphere containing more than 80 times the normal amount of carbon dioxid.

Doctor Reynolds concludes from these experiments that the common explanation of the desirability of ventilation in stables must be revised to conform with the results which he has obtained. It is suggested that the air requirements recommended by various investigators for farm animals confined in stables are altogether too high, and, in most cases, impossible of accomplishment. These requirements vary from 14,000 to 32,000 cubic feet per hour, whereas the stall in which steers were confined during the experiments of Doctor Reynolds, contained only 784 cubic feet of air. It is urged that from the standpoint of economy and profit the fundamental problem in stable ventilation consists in determining the least amount of air change necessary to keep the animals in health and comfort. Further experiments will be carried out to determine the minimum amount of atmospheric change required for this purpose. It is suggested that a well-lighted but poorly ventilated stable is perhaps superior from a sanitary standpoint to one which is poorly lighted and well ventilated.

HOG COTS.[a]

In continuation of a previous article[b] attention is here called to two forms of portable hog houses or hog cots in use at the Wisconsin Station, which are thus described by J. G. Fuller of that station:

> The first type of cot used is represented in figure 2 and is constructed in the following manner: The framework, as the cut shows, is made by using 2 by 4's 16 feet long, sawed in the middle, thus making the bottom dimension 8 feet square, each side 8 feet square, the gable ends being thus formed with rafters 8 feet in length. The front sill is laid flatwise to interfere as little as possible with the young pigs going in and out. The frame rests on short pieces of 2 by 4's railed across each corner, which can be replaced when necessary. When a floor is desired it should be constructed on stringers and the frame made to rest thereon. The following lumber will build the house without floor:
>
> 13 pieces No. 1, 1 inch by 12 inches, 16 feet long.
> 6 pieces, 2 inches by 4 inches, 16 feet long.
> 10 O. G. battens, 16 feet long.
>
> Eight boards, sawed in the middle, make the sides and the remainder, the ends. A small perpendicular slide window is usually made in the rear gable for ventilation. The total cost of material for the house, as shown in the cut, without floor, amounts to practically $11.

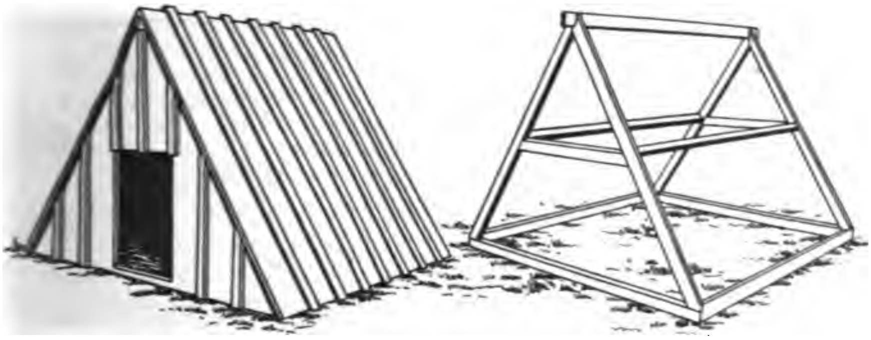

FIG. 2.—Wigwam hog cot used at Wisconsin Station.

Another type of house may be built in two sizes. The larger size, the completed structure shown in figure 3, is 8 feet wide by 10 feet long, 7 feet 2 inches high in front, and 3 feet high in the rear. The smaller house, the frame and completed structure of which are shown in figure 4, is 6 feet wide, 8 feet long, 6 feet 2 inches high in front, and 3 feet high in the rear. The construction of these houses is simple, as may be seen from figure 4.

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[a] Compiled from Wisconsin Sta. Rpt. 1906, p. 42.

[b] U. S. Dept. Agr., Farmers' Bul. 273, p. 11.

The floor is built first, with 2 by 4's as stringers, and the frame is held on the floor by blocks at each corner. The large-sized house is provided with two doors in front and a temporary movable partition in the middle so that the cot can easily be adjusted to accommodate two lots of swine at the same time. On a level with the glass windows there is also a drop window, preferably hung on hinges, fastened at the top for ventilation and sunlight.

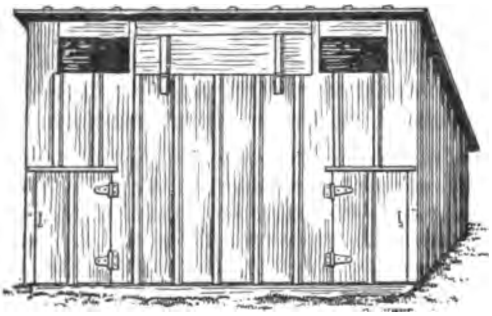

FIG. 3.—Large size hog cot.

The lumber required for the large house, 8 feet wide and 10 feet long, including floor, is as follows:

20 pieces, 2 inches by 4 inches, 10 feet long, for frame and stringers.

2 pieces, 2 inches by 4 inches, 16 feet long, for frame in ends.

20 pieces, 1 inch by 12 inches, 16 feet long, for roof and ends.

5 pieces, 1 inch by 12 inches, 16 feet long (rough), for floor.

15 O.•G. battens, 16 feet long, for sealing cracks between boards.

The material, including the door, hinges, and glass, will cost between $16 and $17.

The lumber required for the house 6 feet wide and 8 feet long is as follows:

12 pieces, 2 inches by 4 inches, 16 feet long, for frame.

4 pieces, 1 inch by 12 inches, 16 feet long (rough), for floor.

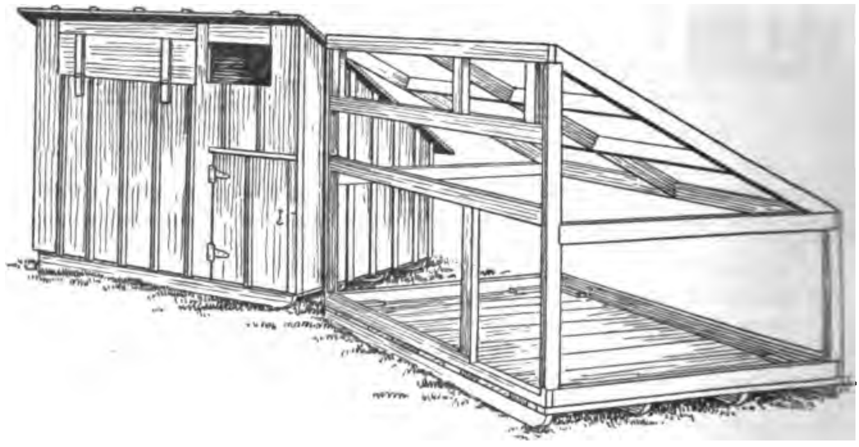

FIG. 4.—Small size hog cot.

13 pieces, 1 inch by 12 inches, 16 feet long, for roof and ends.

10 O. G. battens, 16 feet long, for sealing cracks between boards.

The total cost of material to build the small cot with floor, door, and window complete, amounts to about $12.50. For neatness, economy, durability, and comfort to the animals, this type of cot is excellent. Where it is desirable to keep a number of hogs in one lot the large size is preferable. The small cot will accommodate from three to five mature animals and the large cot from seven to nine.

Although the Wisconsin Station has a large hog house with feed room, scales, etc., the cots have been found a convenient means of enlarging the facilities of the piggery. Of their general advantages Mr. Fuller says:

> With the cot system the farmer or breeder can enlarge his accommodations as the size of his herd increases. The mud and vermin which are sure to accumulate around a large hog house can easily be avoided with the small houses and by occasionally moving them to a fresh spot of ground. Where it is necessary to keep only a few hogs together, or where several animals must be provided with separate quarters, the cot becomes an indispensable factor, and can be used to advantage on any farm.

PRESERVING EGGS IN WATER GLASS.[a]

The experiment station literature and other published results of scientific investigations furnish evidence as to the successful use of water-glass solution for preserving eggs, and this literature has been referred to in earlier bulletins[b] of this Department.

As noted in a previous bulletin of this series[b], much of this literature is summarized by R. W. Thatcher, of the Washington Agricultural Experiment Station, and experiments are reported in which water-glass solution, a brine made of lime and salt, and a commercial egg preservative were tested. In these experiments eggs kept in good condition for home use for at least eight months when preserved either with the water-glass solution or with the lime and salt mixture, but considering cost, quality, appearance, flavor, and other characteristics, Professor Thatcher prefers the water-glass solution.

Particular interest attaches to the data recently published by J. Hendrick, of the University of Aberdeen, as he examined a very large number of eggs preserved in water glass under commercial conditions and also made special studies of the quality and composition of eggs thus preserved for long periods. In general, the preserved eggs were found to be of good quality, though they had not been preserved under the best conditions, as they were not placed in the water-glass solution on the day on which they were laid, but were collected in the country and sent into town in large lots and were two or three days old before preservation. As might have been expected, some of these eggs were bad, but the proportion was not large. In one instance out of 384 dozen eggs preserved between April and June and sold between October and December only 5 dozen, or 1.3 per cent, were bad, and the majority of these were broken or cracked eggs.

Usually the eggs which were preserved in water glass, according to Professor Hendrick—

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[a] Compiled from Washington Sta. Bul. 71; Jour. Agr. Sci., 2 (1907), No. 1, p. 100.

[b] U. S. Dept. Agr., Farmers' Buls. 103, 128, and 273.

Have a nice appearance, as the shells are very clean and fresh looking after the water glass is wiped off them. Even those which had been several years in water glass had a fine, fresh appearance. Another advantage of preservation in water glass over certain other methods is that the contents of the egg do not shrink owing to evaporation. The eggs therefore do not rattle when shaken, no matter how old they are. The cost of preservation is very small.

It was found that eggs which had been kept in water glass for a few months could hardly be distinguished in appearance, flavor, and smell, either raw or cooked, from what are called "fresh eggs"—that is, fresh eggs in the commercial sense, which are eggs which should be free from decomposition or taint, but which may be several days old. A really fresh egg, only a few hours laid, is easily distinguished in flavor and appearance when cooked from the "fresh egg" or preserved egg, and is known as a "new-laid" egg. The eggs which had been preserved in water glass for about six months tasted and smelled like well-kept eggs a few days old. As the eggs in question were a few days old when they went into the water glass, they were not appreciably changed to my eye and palate by a few months' stay in water glass.

As the eggs get older, however, a distinct change is found which can be appreciated both by the eye and palate. "Eggs which have been three or four years in water glass are easily recognized. The white becomes pink in color and very liquid. The egg acquires a slightly peculiar taste which * * * suggested soda. At the same time even when four years old the eggs had no unpleasant taste or smell, and the white coagulated in the usual manner in cooking. Though there was a slight characteristic odor when the eggs were cooked, it was not a stale or bad odor and did not suggest sulphureted hydrogen. The changes in the preserved eggs take place very gradually. At one year old they are hardly noticeable; at two years they are distinct, but not so distinct as at three or four years old.

To further test the effects of the preserving solution fresh eggs and eggs which had been kept in water glass one to three years were analyzed and it was found that there was practically no change in their composition even after lengthened immersion in the solution. Practically no silica and little, if any, soda found their way into the eggs. The eggs do not dry up and there is scarcely any change in their ash content, though they contain slightly more soda than fresh eggs. "The alkalinity of the contents of the eggs appeared to increase with the length of time they were in water glass, but the increase was small, and in a complicated substance like egg it was found difficult to measure it accurately." "The slight alteration in the flavor of the egg and in the liquidness of the white may be due to the increase in soda."

To ascertain whether silica was deposited in the egg shell from the water-glass (sodium silicate) solution, samples of shell and membrane from a number of eggs were analyzed and it was found that the amount of silica in eggs preserved for three years amounted to nearly 2.5 per cent as compared with 0.5 per cent in the shells of fresh eggs. "It appears, then, that a slow deposition of silica takes place in the shell of the egg. The percentage of lime in the shells remains practically constant. This deposition of silica in the shells probably blocks up the pores of the shells to some extent and renders them less permeable."

According to Professor Hendrick, the sirup-thick water glass, such as is used after proper dilution for egg preservation, is a sodium silicate. As shown by his analyses it does not contain sufficient soda to neutralize all the acid present, and the solution is strongly alkaline in reaction. A sample of sirup-thick water glass contained 37.91 per cent silica, 16.48 per cent soda, and 0.14 per cent potash, and a solution prepared for preserving eggs, 2.76 per cent silica, 1.20 per cent soda, and 0.01 per cent potash.

On the whole, Professor Hendrick regards the water-glass solution as one of the most popular and widely used preservatives for eggs. "Though this method was introduced only comparatively recently, it has largely superseded older methods, and also appears to have led to much more frequent preservation of eggs on the small scale in households and by small traders. The method is simple and effective. The eggs are obtained when they are plentiful and cheap in spring and preserved for use during the winter months." In such cases it is necessary to keep them for about six months, but they may be kept much longer, for in the experiments referred to above some were left in a solution of water glass as long as four years and were not decayed.

It is assumed that eggs preserved in water glass will be so labeled when offered for sale.

AMERICAN CAMEMBERT CHEESE.[a]

The genuine Camembert cheese is made in France, particularly in the northwestern part, where the industry, originating a little over a century ago in the village of Camembert, in Orne, and shifting soon into Calvados, has reached great importance. This variety of cheese is one of the most highly esteemed of the many soft kinds and has accordingly been imported to a considerable extent into the United States. It is but natural, therefore, that in keeping with the American desire to produce at home the products of all kinds that are of local demand, efforts should have been made to manufacture cheese of the Camembert type in this country.

Until recently these attempts have not been wholly successful. For about three years this Department and the Connecticut Storrs Station, in cooperation, have been investigating thoroughly the making and ripening of Camembert cheese, and in an earlier number of this series[b] has already been noted the substance of a preliminary report on this work, in which it was shown that the principal agents concerned in the ripening process are two species of molds, known technically as *Penicillium camemberti* and *Oidium lactis*.

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[a] Compiled from Connecticut Storrs Sta. Bul. 46.

[b] U. S. Dept. Agr., Farmers' Bul. 225, p. 31.

The manufacture of the Camembert type of cheese at the Connecticut Storrs Station has now been carried on sufficiently long and with such a high degree of success that efforts to establish the enterprise on a commercial basis in this country seem abundantly warranted. To this end Director L. A. Clinton in the introduction to a recent bulletin announces that the Connecticut Storrs Station is now prepared to assist factories and individuals in making this type of cheese, and Mr. Theodore Issajeff in the body of the bulletin describes the plant and equipment necessary and gives directions for making the cheese. While anyone specially interested in making Camembert cheese should of course secure a copy of the bulletin,[a] nevertheless a brief outline of the process of manufacture as given in it and which, it may be mentioned, differs in some respects from that employed in France, may be of some general interest, and with this in view the following points are noted:

The fresh whole milk is warmed to 85° F., and a starter, preferably a pure culture of lactic-acid bacteria, is added. A rather high degree of acidity (0.30 to 0.35 per cent) is allowed to develop, and sufficient rennet (about 8 to 10 cc. per 100 pounds of milk having an acidity of 0.3 per cent) is then added to the milk at the temperature mentioned to secure the desired texture of the curd in one and one-half to two hours. The curd is cut, stirred gently, and allowed to stand for about fifteen minutes, when the bulk of the whey is removed. After being stirred thoroughly the curd is dipped into galvanized-iron forms or hoops, 4 inches in diameter and 5 inches in height and open at both ends. They rest upon a mat made of fine bamboo strips. The cheeses are allowed to drain naturally for four to five hours, when they are inoculated with cultures of the molds mentioned and turned. The next morning they are removed from the forms and salted by rubbing salt on the surface. When the curd is not cut, as is the custom in France, a higher acidity of the milk is necessary (0.40 to 0.45 per cent) and a longer period is allowed for draining. The next day after salting the cheeses are transferred to the first ripening room which must be nearly saturated with moisture and kept at a temperature of 60 to 62° F. When placed on boards the cheeses are turned daily. During the second week they are wrapped in tin foil or parchment paper and usually put into small round wooden boxes, after which they are transferred to the second curing room, which is kept at a temperature of 56 to 60° and may have a lower percentage of moisture than the first room. Here the cheeses remain for one to two weeks longer before they are in the best condition for consumption.

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[a] This bulletin has also been published recently as Bulletin 98 of the Bureau of Animal Industry of this Department.

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Issued May 31, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 297.

METHODS OF DESTROYING RATS.

BY

DAVID E. LANTZ,
Assistant, Bureau of Biological Survey.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., May 15, 1907.

Sir: I have the honor to transmit herewith for publication Farmers' Bulletin No. 297, containing concise directions for the destruction of rats, prepared by David E. Lantz, an assistant in this Bureau. The damage done by these rodents, both in cities and in the country, is enormous, and the calls for practical methods of destroying them are correspondingly numerous and urgent. It is believed that by following the directions here given the numbers of this pest can be greatly reduced and the losses from them proportionally diminished.

Respectfully,

C. Hart Merriam,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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Fig. 1.—Method of baiting guillotine trap

METHODS OF DESTROYING RATS.

INTRODUCTION.

The brown or Norway rat (*Mus norvegicus*) is the worst mammal pest in the United States, the losses from its depredations amounting to many millions of dollars yearly—to more, indeed, than the losses from all other injurious mammals combined.[a] In addition to its destructive habits, this rat is now known to be an active agent in disseminating infectious diseases, a fact which renders measures for its destruction doubly important.

Introduced into America about the year 1775, the brown rat has supplanted and nearly exterminated its less robust relative, the black rat, and despite the incessant warfare of man has extended its range and steadily increased in numbers. Its dominance is due to its great fecundity and its ability'to adapt itself to all sorts of conditions. It breeds three or four times a year and produces from 6 to 12, and even more, young at a litter. Young females breed when only 4 or 5 months old. The species is practically omniverous, feeding upon all kinds of animal and vegetable matter. It makes its home in the open field, the hedge row, and the river bank, as well as in stone walls, piers, and all kinds of buildings. It destroys grains when newly planted, while growing, and in the shock, stack, mow, crib, granary, mill, elevator, or ship's hold, and also in the bin and feed trough. It invades store and warehouse and destroys fur, laces, silks, carpets, leather goods, and groceries. It attacks fruits, vegetables, and meats in the markets, and destroys by pollution ten times as much as it actually eats. It carries disease germs from house to house and bubonic plague from city to city. It causes disastrous conflagrations; floods houses by gnawing lead water pipes; ruins artificial ponds and embankments by burrowing; destroys the farmers' pigs, eggs, and young poultry; eats the eggs and young of song and game birds; and damages foundations, floors, doors, and furnishings of dwellings.

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[a] Several species of rats are known as "house rats," including the black rat (*Mus rattus*), the roof rat (*Mus alexandrinus*), and the brown rat (*Mus norvegicus*). Of these, the last is the commonest and most widespread in this country. Not one of these species is a native, but all were imported from the Old World. As their habits in general are similar, the instructions given in the bulletin apply alike to all.

METHODS OF DESTROYING RATS.

A compilation of all the methods of destroying rats practiced in historic times would fill a volume. Unfortunately, the greater number of them are worthless or impracticable. Few have more than temporary effect upon their numbers, and even the best of them fail unless persistently applied. Conditions vary so much that no one method of dealing with this pest is applicable in all cases. Among the more important measures to be recommended for actively combating the brown rat are: (1) Poisons; (2) traps; (3) ferrets; (4) fumigation, and (5) rat-proof construction of buildings.

POISONING.

Barium Carbonate.—One of the cheapest and most effective poisons for rats and mice is barium carbonate, or barytes. This mineral has the advantage of being without taste or smell; and, in the small quantities used in poisoning rats and mice, is harmless to larger animals. Its action on rodents is slow, but reasonably sure, and has the further advantage that the animals before dying, if exit be possible, usually leave the premises in search of water. Its employment in houses, therefore, is rarely followed by the annoying odor which attends the use of the more virulent poisons.

The poison may be fed in the form of a dough made of one-fifth barytes and four-fifths meal, but a more convenient bait is ordinary oatmeal, with about one-eighth of its bulk of barytes mixed with water into a stiff dough; or the barytes may be spread upon bread and butter or moistened toast. The prepared bait should be placed in rat runs, a small quantity at a place. If a single application of the poison fails to drive all rats from the premises, it should be repeated with a change of bait.

Strychnine.—Strychnine is a more virulent poison, but its action is so rapid that the animals often die upon the premises, a circumstance which prohibits its use in occupied dwellings. Elsewhere strychnine may be employed with great success. Dry strychnine crystals may be inserted in small pieces of raw meat, Vienna sausage, or toasted cheese, and these placed in the rat runs; or oatmeal may be wet with a strychnine sirup, and small quantities laid out in the same way.

Strychnine sirup is prepared as follows: Dissolve a half ounce of strychnia sulphate in a pint of boiling water; add a pint of thick sugar sirup and stir thoroughly. A smaller quantity of the poison may be prepared with a proportional quantity of water. In preparing the bait it is necessary that all the oatmeal should be moistened with sirup. Wheat is the most convenient alternative bait. It should be soaked over night in the strychnine sirup.

Other Poisons.—The two poisons most commonly used for rats and mice are arsenic and phosphorus, nearly all commercial preparations containing one or the other as a basis. While experiments prove that rats have great powers of resistance to arsenic, it may sometimes be used advantageously as an alternative poison. Preparations of phosphorus sold by druggists are often too weak to be effective; and home-made mixtures, when of sufficient strength, are dangerous, as rats may carry the baits into walls or crannies and thus cause fires. For these and other reasons the Biological Survey does not recommend preparations containing phosphorus.

Poison in the Poultry House.—For poisoning rats in buildings and yards occupied by poultry, the following method is recommended: Two wooden boxes should be used, one considerably larger than the other, and each having two or more holes in the sides large enough to admit rats. The poisoned bait should be placed on the bottom and near the middle of the larger box, and the smaller box should then be inverted over it. Rats thus have free access to the bait, but fowls are excluded.

TRAPPING.

Trapping, if persistently followed, is one of the most effective methods of destroying rats. The improved modern traps with a wire fall released by a baited trigger and driven by a coiled spring have marked advantages over the old forms, and many of them may be used at the same time. These traps, sometimes called guillotine traps, are of many designs, but the more simply constructed are to be preferred. Probably those made entirely of metal are the best, as they are less likely to absorb and retain odors.

In illustration of the effectiveness of traps, it may be related that a year or two ago a large department store in Washington experienced heavy losses of gloves, lace curtains, and other merchandise from rat depredations. For several months the damages amounted to from $10 to $30 nightly. After many unsuccessful attempts to abate the nuisance the managers were advised to try the improved traps. As a result 136 rats were killed during the first twenty nights, when the losses practically ceased, and the method has been continued in the store ever since with satisfactory results.

Guillotine traps should be baited with small pieces of Vienna sausage (Wienerwurst) or bacon. The trigger wire should be bent inward to bring the bait into proper position to permit the fall to strike the rat in the neck, as shown in the illustration (fig. 1).

Other excellent baits for rats are oatmeal, toasted cheese, toasted bread (buttered), and sunflower or pumpkin seeds. When seed, grain, or meal is used with a guillotine trap, it may be placed on the trigger plate, or the trigger wire may be bent outward and the bait sprinkled under it.

Wire cage traps (French) also are useful for catching rats, but in the long run the kinds recommended above are much more effective. While trapping, all other food should be removed and the trap bait should be changed often. Rats are very suspicious, and baits and traps should be handled as little as possible. Increased success may be secured both in trapping and poisoning if the rats are fed for a night or two with the kinds of food to be used for bait.

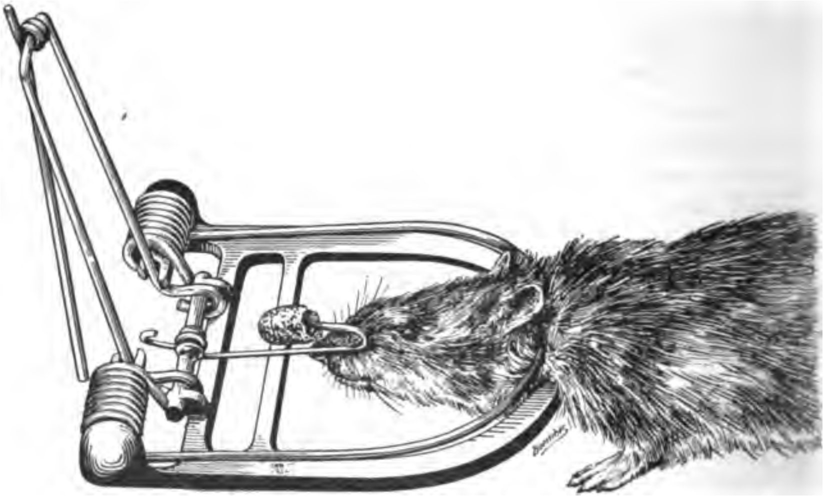

Fig. 1.—Method of baiting guillotine trap.

USE OF FERRETS AND DOGS.

A ferret is useful for the purpose of driving rats out of burrows and other hiding places so that dogs can capture them. An experienced person with dogs and ferrets trained to work together can kill many rats when they are numerous. But the amateur ferreter is likely to be greatly disappointed.

In the rice fields of the far East the natives build numerous piles of brush and rice straw and leave them for several days until many rats have taken shelter in them. A portable bamboo inclosure several feet in height is then set up around each pile in succession and the straw and brush are thrown out over the top while dogs and men kill the trapped rodents. Large numbers are killed in this way, and the plan with modifications may be utilized in America with satisfactory results. A wire netting of fine mesh may be used for the inclosure. The scheme is applicable at the removal of grain, straw, or hay stacks, as well as brush piles.

FUMIGATION.

Rats may be destroyed in their burrows in the fields, and, still more important, in levees and rice-field dikes, by the use of carbon bisulphid. A wad of cotton or other absorbent material is saturated with the liquid and pushed into the burrow, the opening being packed with soil to prevent escape of the gas. All animals in the burrow are asphyxiated. Fumigation about buildings is not so effective, as the gas can not readily be confined.

RAT-PROOF CONSTRUCTION.

The best way of excluding rats from buildings, whether in the city or country, is by the use of cement in construction. As the advantages of this material are coming to be generally understood, its use is rapidly extending to all kinds of building. Dwellings, dairies, barns, stables, chicken houses, ice houses, bridges, dams, silos, tanks, cisterns, root-cellars, hotbeds, sidewalks, and curbs are now often made wholly of concrete. In constructing dwelling houses the additional cost of making the foundations rat-proof is slight as compared with the advantages. The cellar walls should have concrete footings and the walls themselves be laid in cement mortar. The cellar floor should be of " medium " rather than " lean " concrete, and all water and drain pipes should be surrounded with concrete. Even an old cellar may be made rat-proof at comparatively small expense. Rat holes may be permanently closed by a mixture of cement, sand, and broken glass or sharp bits of stone.

Rat-proof granaries, corncribs, and poultry houses may be constructed by a liberal use of concrete in the foundations and floors.

Rats, mice, and sparrows may be excluded from corncribs by the use of either an inner or an outer covering of fine-mesh wire netting sufficiently heavy to resist the teeth of rats.

The common custom of setting corncribs upon posts with inverted pans at the top often fails because the posts are not long enough to insure that the lower cracks of the structure are beyond jumping reach of rats. The posts should project at least 3 feet above the surface of the ground.

NATURAL ENEMIES OF RATS.

The value of carnivorous mammals and the larger birds of prey in destroying rats should be more fully recognized, especially by the farmer and the game preserver. Chief among the animals that are useful in destroying these rodents are the fox, skunk, and weasel. and the larger species of owls and hawks. Rats destroy more poultry and game, both eggs and young chicks, than all the birds and wild mammals named combined, yet some of our most useful birds of prey and carnivorous mammals are persecuted almost to the point of extinction. An enlightened public sentiment should cause the repeal of all bounties on these animals and afford protection to the majority of them.

CONCLUSIONS.

By the persistent use of traps, occasional resort to poison, and the exercise of forethought in the construction of farm buildings so as to minimize the opportunities for harborage, farmers and others may prevent the greater part of the loss and annoyance they now experience from rat depredations. The same statement applies in great measure to city and village conditions. Hence cooperation in the warfare on rats is particularly important and can not be too strongly urged.

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1004 Issued July 12, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 298.

FOOD VALUE OF CORN AND CORN PRODUCTS.

BY

CHARLES D. WOODS, D. Sc.,
Director Maine Agricultural Experiment Station.

Prepared under the supervision of the Office of Experiment Stations.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., May 6, 1907.

Sir: Believing that it constitutes a useful summary of data on the subject, I have the honor to transmit herewith and recommend for publication as a Farmers' Bulletin a report on the uses of corn and corn products as food, by Charles D. Woods, director of the Maine Agricultural Experiment Station, who has long been associated with the Office of Experiment Stations in its cooperative nutrition investigations.

Studies of the nutritive value of corn and corn products, particularly those carried on at the Maine and Minnesota experiment stations and at Teachers' College, Columbia University, have formed an important part of the cooperative nutrition investigations of this Office.

The special questions studied have included the digestibility of different sorts of corn bread and other corn-meal dishes, the digestibility of hominy, corn breakfast foods and green corn, the relative nutritive value of corn meal ground in different ways, and the culinary qualities and methods of manipulating old-fashioned and modern corn meal in order to secure uniform results. The data summarized from these investigations, from miscellaneous bulletins and reports of the agricultural experiment stations, and other sources, make it plain that corn meal is one of the most important food cereals when judged by its composition, digestibility, wholesomeness, palatability and relative economy as a source of nutritive material.

Acknowledgment should be made to Miss Helen W. Atwater for assistance in compiling and arranging the data presented.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

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CORN AND CORN PRODUCTS AS FOOD.

INTRODUCTION.

The tall vigorous cereal plant known as maize, or Indian corn, is a native of the Western Hemisphere, and has been cultivated throughout the warmer regions of the Americas for twenty centuries or more. It has been claimed often that it is also indigenous to the Old World, but there is no warrant for this belief, though it has been grown in parts of Europe in which the climate is particularly favorable ever since Columbus brought the seed from the West Indies. It has also long been grown by the Arabs of northern and the Kafirs of southern Africa, and is a staple crop throughout vast regions of the African continent, as well as of southern and central Asia, China, and Australia. To attain its best development, corn needs both warmth and abundant sunshine, and so the climate of the northern regions of Europe is unsuited to its cultivation and it is there grown mainly for forage, any grain that reaches maturity being inferior in quality and little esteemed for human food.

Following the potato famine of 1847, an effort was made to introduce Indian corn into Ireland, and it has since been considerably eaten there, principally in the form of porridge, or "stirabout;" otherwise it can hardly be ranked as an important foodstuff in Great Britain, except, perhaps, in the dietaries of some of the public institutions, where it replaces more expensive cereals. In the Mediterranean and Balkan regions, however, where conditions are more favorable, its easy cultivation and abundant yield have made it one of the principal food crops. It has been estimated that Indian corn, or Turkish corn, as it is quite commonly known in Italy, forms the main food for two-thirds of the rural population of that country.

Its importance in America may be gathered from its name. Whereas in English-speaking regions of Africa it is known as mealies, and in Europe as maize, a name said to be derived from that originally used in the West Indies, in America it has usurped the name corn, which in Great Britain still refers to any grain regardless of kind. The fact that we sometimes modify this to Indian corn is, of course, a recognition of its origin.

The prevalent opinion is that corn was native to Central America and Mexico, and that it passed through the same stages of cultivation and dissemination which other important food plants have known. The Maya tribes, the relics of whose civilization are very old, cultivated corn, and it appears as the symbol of religion and prosperity in their art just as do other cereals in the early art of the Eastern Hemisphere. From the Mayas its cultivation spread throughout northern and western South America, the West Indies, and a great part of North America, and traces of corn have been found in the prehistoric mounds of Ohio, in the cliff dwellings of the Southwest, and in Peruvian mummy pits.

The grain kept from decay and destruction by the great dryness of many of these prehistoric burial places differs little, if at all, from varieties grown to-day. The stories often repeated of the raising of plants from such corn, or from the grain found in Egyptian tombs, are without foundation, as the life of the germ is not prolonged indefinitely, even under favorable conditions, though the chemical nature of the grain may remain practically unchanged.

By the time European travelers penetrated into the New World, corn was cultivated by all but the most northern and western tribes of North American Indians. When Cartier ascended the St. Lawrence he found fields of it where Montreal stands to-day. Hariot, in his account of the Virginia Colony, published in 1588, writes of maize as follows: "The graine is about the bignesse of our ordinary English peaze, and not much different in forme and shape, but of divers colours: some white, some red, some yellow, and some blew. All of them yeelde a very white sweete flowre; being used according to his kind it maketh a very goode bread."

The early chronicles of Virginia contain many descriptions of the cultivation of corn, beans, pumpkins, and other plants by the Indians; and in very early times in the Jamestown colony Indian prisoners were forced to teach the English settlers how to plant and till the grain. An early chronicle of the Plymouth settlement told how, in the dreadful winter of 1620–21, the colonists bought "eight hogheads of corne and beanes" from their Indian neighbors, and in the following spring learned from a friendly red man "bothe ye manner how to set it and after how to dress and tend it." For a time it was the principal breadstuff in the American colonies. Little by little, however, as wheat and other cereals became acclimatized these supplanted it among the well to do, though it has never passed entirely out of use in any section of the United States, and in some districts, particularly in the South and Southwest, it is still a staple cereal grain.

According to the census of 1900, almost a third of all the land under cultivation in the United States was devoted to corn. It was grown on 88.6 per cent of all the farms in the country, and the crop for 1 was valued at $828,258,326. Wheat, the next most important crop occupied only 18.1 per cent of the cultivated land, and was valued at $369,573,528. Of course these figures do not represent the relative importance of the two grains as human food, for while practically all the wheat is used in that way, either at home or in those countries to which it is exported, the greater part of the corn crop is used for feeding stock or as raw material in several important manufacturing industries. A better idea of its importance as human food may be gained from a recent compilation of American dietary studies made with many families in different parts of the country. Among 72 families in comfortable circumstances corn preparations furnished on an average 1.6 per cent of the total food; among 161 families, mostly foreigners in the congested districts of large cities, only 0.3 per cent; among Tennessee and Georgia mountaineers, 23 per cent, and among southern negroes 32.5 per cent. These figures refer only to the meals, flours, and similar preparations made from the ripe dried grains.

While meal, hominy, and similar products are the principal corn foods, there are a number of others of much importance. The unripe ears, especially of certain sweet varieties, are a favorite vegetable on American tables, and pop corn is a typical American food product of which the total amount consumed is very large. The roasted kernels of ordinary corn are sometimes used as a substitute for coffee, and apparently form a part of some of the mixtures commonly sold as coffee substitutes. Starch, glucose, gluten, and oil are also made from corn; and these and other important corn products will be discussed in later sections.

From an agricultural standpoint, corn is of the utmost importance, and this might be known, if for no other reason, from the fact that there is, perhaps, not one of the agricultural experiment stations, established in every State and Territory, which has not studied some phase of the corn question, either methods of cultivation, improvement of varieties, composition, feeding value for farm animals, or importance as a food for man. The State departments of agriculture and like organizations have also carried on much work of a similar nature. The importance of corn as an article of diet has been taken up especially at the Maine and the Minnesota experiment stations. The Department of Agriculture, and particularly the Bureau of Chemistry,[a] have also been large and important contributors to our knowledge of the composition and uses of corn and corn products.

As regards the preparation of corn for the table the literature is very considerable, almost every cookbook and journal of cookery containing recipes for corn dishes, while several such books are devoted exclusively to corn and corn products.

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[a] U. S. Dept. Agr., Bureau of Chemistry Bul. 13, pt. 9, and Bul. 50; The food value f maize, etc., in Report on the Use of Maize (Indian corn) in Europe (U. S. Dept. gr., Spec. Rpt. 1891).

FOOD VALUE OF CORN.

The food value of corn and its products, as compared with each other and with other food materials, of course depends mainly on the amount of nutritive materials or nutrients which the digestive organs can extract for the use of the body. Besides the water found in all food materials, even those which are apparently perfectly dry, the actual nutrients are grouped in four classes: (1) Protein or nitrogenous material; (2) fat; (3) carbohydrates, including starches, sugars, and the very indigestible constituents known as crude fiber or cellulose; and (4) mineral matters or ash. The two functions of the food are to furnish material for the building up and repair of body tissue and to supply energy for muscular work and body heat. Protein, fats, and carbohydrates alike can yield energy, but since only protein can serve for the necessary tissue building, this is usually considered its main function and the fats and carbohydrates are relied on to furnish most of the energy. All the changes which corn or other food undergoes in being prepared for eating are intended mainly to add to its palatability and get it into a form in which the nutrients can be most easily and completely utilized by the body.

STRUCTURE AND COMPOSITION.

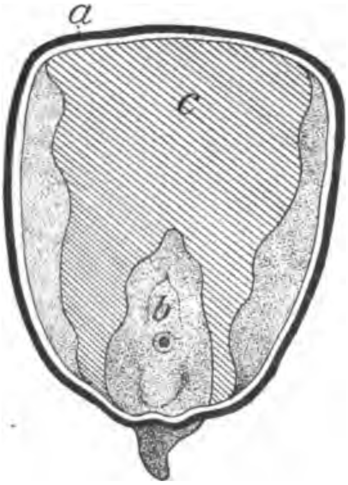

FIG. 1.—Diagrammatic section of a grain of corn: *a*, skin; *b*, germ; *c*, endosperm.

Although the stalk and leaves are important cattle feeds, only the kernels of corn are ordinarily used for human food. They grow in double rows along a woody cob, from which they are easily shelled when ripe. The color of the skin may be white, yellow, red, purplish blue, or a combination of these, according to variety. They are all either white or yellow inside and differ little on an average save in color. The kernel or seed, it must be remembered, is not inert, but a living thing, which under favorable conditions will develop into a new plant, and each part of it is made up of cells especially fitted for a particular rôle in this process of reproduction. Roughly speaking, the seed consists of three main divisions: The skin, the germ, and the endosperm (see fig. 1). The skin, which makes about 6 per cent of the weight of the seed, holds the whole together and protects the delicate interior parts. It is made up principally of tough cellulose or crude fiber with some mineral matter embedded in it. The germ is larger in corn than in most cereals, and forms in average corn about 10 per cent by weight of the grain, whereas in wheat it is only 6 or 7 per cent. It contains the embryo from which the new plant will develop under favorable conditions. The endosperm constitutes about 84 per cent by weight of the grain, and represents the food which the parent plant has stored for the early growth of the new plant. In the germ and endosperm, the cellulose walls of the cells are very much thinner than in the skin, and surround a network of nitrogenous material called protoplasm in which the life of each cell seems to reside. The food materials which the plant has stored for future use lie in the meshes of this protoplasmic network, together with some moisture; in the germ much of the stored material is fat and mineral matters. In the outer layers of the endosperm (see fig. 2), there are stored grains of a protein substance known as aleurone, and in the inner portions are found quantities of tiny starch grains with small amounts of protein and mineral matter. Table 1, taken from analyses made at the New Jersey Agricultural Experiment Station, shows how these constituents are distributed throughout the grain, the data being expressed on a water-free basis.

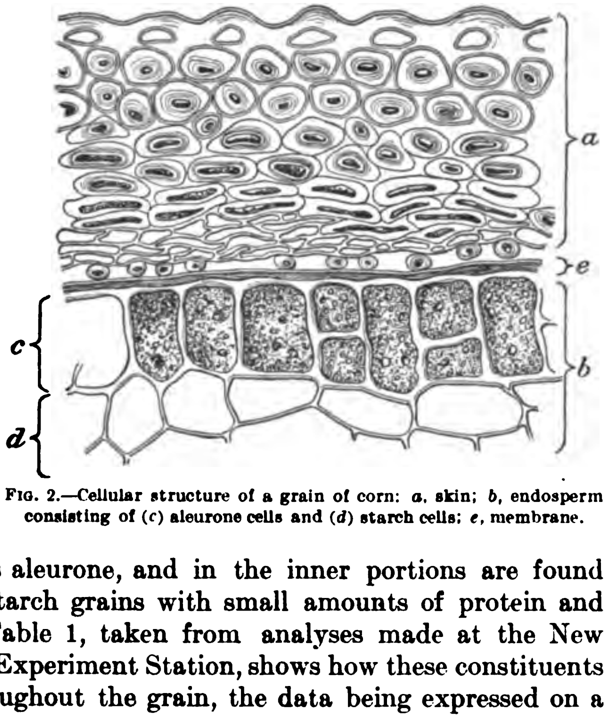

FIG. 2.—Cellular structure of a grain of corn: *a*, skin; *b*, endosperm consisting of (*c*) aleurone cells and (*d*) starch cells; *e*, membrane.

TABLE 1.—*Composition of different portions of a grain of corn.*

Portion of corn kernel.	Proportion in original grain.	Water.	In water-free material.				
			Protein.	Fat.	Total carbohydrates.		Mineral matters.
					Starch, sugar, etc.	Crude fiber.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Whole kernel	100.0	24.7	12.7	4.3	79.3	2.0	1.7
Skin	5.6	15.3	6.6	1.6	74.1	16.4	1.3
Germ	10.2	29.6	21.7	29.6	44.7	2.9	1.1
Endosperm	84.2	24.7	12.2	1.5	85.0	.6	.7

From these figures it may be calculated that 51 per cent of the cellulose of the grain is found in the skin, 65 per cent of the fat and about 16 per cent of the protein in the germ, 90 per cent of the starch and 84 per cent of the protein in the endosperm.

Grain of any kind is hygroscopic—i. e., has the power of absorbing water from the air—and the amount of moisture in it varies according to the climate and other conditions under which it is grown and stored. The proportion of nutrients in different varieties of the same species also differs considerably, being influenced by the selection of seed, the method of cultivation, the season, and other factors. The figures in the following table were prepared from many analyses and represent the average composition of the whole grains of corn and other common American cereals as ordinarily found in the market.

TABLE 2.—*Average composition of cereal grains.*

Kind of cereal.	Water.	Protein.	Fat.	Total carbohydrates.		Mineral matters.	Fuel value per pound.
				Starch, sugar, etc.	Crude fiber.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Indian corn	10.8	10.0	4.3	71.7	1.7	1.5	1,800
Barley	10.9	11.0	2.3	69.5	3.8	2.5	1,735
Buckwheat	12.6	10.0	2.2	64.5	8.7	2.0	1,600
Kafir corn	12.5	10.9	2.9	70.5	1.9	1.3	1,630
Oats	11.0	11.8	5.0	59.7	9.5	3.0	1,730
Rice	12.0	8.0	2.0	76.0	1.0	1.0	1,720
Rye	10.5	12.2	1.5	71.8	2.1	1.9	1,740
Wheat	10.6	12.2	1.7	71.3	2.4	1.8	1,750

As far as these figures show, the average water content of these cereals is almost the same, ranging from 10 to 12 per cent. Corn on an average contains 10 per cent protein, which is about 2 per cent less than the average rye or wheat contains, but 2 per cent more than the average rice. Its fat amounts to 4.3 per cent, or about the same proportion as is found in oats and over twice as much as in most of the other grains. In the proportion of starch they contain, corn, wheat, and rye are practically the same, and surpass all the other common grains except rice. The cellulose content of corn is smaller than that of any of the other cereals except rice, and it also contains a comparatively small proportion of mineral matters.

Though the proportions of the several nutrients in corn and other common cereals are much the same, the individual compounds[a] making up these groups differ considerably. As shown by extended studies at the Connecticut State Station, zein is the typical protein of maize, and it differs in its properties considerably from the gluten of wheat or the proteids of other cereal grains. The fat of corn has a different chemical composition from that of wheat or other grains, and the ash also is characteristic.

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[a] For discussion of the properties of corn proteids, see Connecticut State Sta. Rpts 1891, p. 136; 1896, p. 391. Data regarding fat are summarized in Ann. Rpt. Ohi Dairy and Food Comr., 21 (1906), p. 18, and of carbohydrates in U. S. Dept. Agr Bureau of Chemistry Bul. 13, pt. 9.

There is known to be some variation in the number and kind of starches, sugars, cellulose, and other bodies included under the heading "Carbohydrates," which occur in corn and other cereals, but it is generally believed that the bodies like starch which occur in the different plants have the same percentage composition. In size, appearance, the distribution of the concentric layers making up the granule, the readiness with which the starch absorbs water and is acted upon by ferments, and in other properties, starch grains occurring in different cereals exhibit considerable variations. The starch granules of corn resemble those of oats somewhat in appearance, but are larger.

Fat, when burned in the body, gives off 2.25 times as much heat as carbohydrates and protein, and corn, which contains relatively large proportions of both fat and carbohydrates, has a comparatively high fuel or energy value. The points in which the chemical composition of corn is superior to the other common cereals, then, are its richness in fat and starch and its small content of crude fiber. Its deficiencies lie in the small quantities of protein and mineral matters. The quality of its protein is less desirable for bread making than that of wheat and rye, as will be discussed later (see p. 17).

MILLING.

Occasionally whole grains of corn are used for human food, as in parched corn, pop corn, etc., but as a rule it is found preferable to break them up more or less before cooking. The Indians ground corn between two flat stones or pounded it, sometimes parching it beforehand. Another simple method, employed by the pioneer settlers, was to grate the newly ripened ears on a coarse grater, and many persons still maintain that in this way the best flavor of the grain is obtained.

Before the development of railways and elaborate milling machinery each community had its mill, usually by a stream, and here all the grain of the neighborhood was ground. The corn was simply crushed between the grooved millstones to the desired fineness. If the meal was intended for human food, the coarse particles of skin or bran were usually bolted out, though this was often done at home instead of at the mill. Nowadays cereals of all sorts are shipped from many districts to central mills in which complicated machinery grinds the grain much more carefully than was possible fifty years ago, and although the milling of corn is not as elaborate as that of wheat, it is no longer a simple process of crushing. To begin with, the grain is usually kiln dried (see p. 28), a process which hinders decay by lessening the vitality of molds and decay-producing bacteria, if they are present, and by driving off the water, without which such minute forms of life can not grow. Drying the grain also makes the skin separate more readily from the grain, and its removal before grinding is an advantage, since the skin consists largely of indigestible cellulose, which renders the meal coarse and rough without adding much to the food value. The germ lowers the keeping quality of the meal because its abundant fat easily becomes rancid, and now it is usually removed before the grain is ground. A machine known as the "degerminator" loosens both skin and germ, which are then easily bolted out, and the remaining endosperm is ground alone and bolted and purified by means of air currents. The offal removed consists of the hull, germ, floury particles, and some of the flinty portion of the corn, and constitutes 30 to 35 per cent of the entire weight of the grain. Meal from such degerminated grain is commonly called "granulated corn meal" and has almost replaced the old-fashioned kind for human food in the North, although the latter is still very popular in the Southern States. Both kinds are made in varying degrees of fineness. Very finely ground and bolted corn meal is known as corn flour, and is made from both yellow and white corn.

While meal is the form in which corn is best used for bread making, the less finely ground products, such as hominy and samp, are often preferred for porridge. The use of these terms is very uncertain and confusing. In colonial days in New England, samp designated the kernels of freshly harvested corn, but this use has now disappeared. In some parts of the country, the kernels which have been simply crushed sufficiently to loosen the hulls are known as samp, and those which have been crushed into bits not much larger than mustard seeds are called hominy, but in other sections the names are exactly reversed, while in many regions all such corn preparations are called hominy. The germ and skin are now usually removed in preparing these products, and their chemical composition is not, therefore, the same as that of the original grain. How this varies may be seen from Table 3, which gives analyses of corn prepared in different ways. The corn meals, both bolted and unbolted, were simply crushed, while the granular meals, hominy and samp, were "degerminated" before grinding.

TABLE 3.—*Average composition of corn products and wheat flour.*

Kind of material.	Water.	Protein.	Fat.	Carbohydrates.		Mineral matters.	Fuel value per pound.
				Starch, sugar, etc.	Crude fiber.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Corn, whole grain, average	10.8	10.0	4.3	71.7	1.7	1.5	1,795
Corn with low protein content	10.5	6.0	3.8	78.5		1.2	1,685
Corn with high protein content	10.5	12.9	4.4	70.8		1.4	1,695
Corn, white	11.4	10.8	5.0	68.8	2.5	1.5	1,690
Corn, yellow	11.9	10.7	4.8	68.9	2.2	1.5	1,690
Sweet corn (matured)	8.8	11.6	8.1	66.8	2.8	1.9	1,750
Pop corn	10.7	11.2	5.2	69.6	1.8	1.5	1,710
Hominy, fine	11.0	9.4	.7	78.2	.4	.3	1,810
Samp, coarse	10.8	8.3	.5	79.4	.7	.3	1,770
Corn meal (whole grain ground), unbolted	12.0	8.7	4.7	71.1	2.2	1.3	1,850
Corn meal (whole grain ground), bolted	12.0	8.9	4.9	72.0	1.2	1.0	1,765
Corn meal, granulated	12.5	9.2	1.9	74.4	1.0	1.0	1,770
Corn flour, i. e., finely ground and bolted corn	12.6	7.1	1.3	77.5	.9	.6	1,645
Corn starch	....	....	....	90.0	....	....	1,675
Liquid glucose (for table use)	16.0	....	....	83.5	....	.5	1,120
Corn oil	....	....	100.0	....	....	....	4,040
Wheat flour	11.1	11.4	1.3	75.5	.1	.6	1,770

The values given in the table for corn of low and of high protein content show that there may be a considerable range in the proportions of the different nutrients present. Such variations are due to cultural varieties, to methods of cultivation, seed selection, and other similar factors, and are noted in corn of all types. The influence of different factors on the protein content has been studied at the Illinois, Minnesota, Kansas, and other agricultural experiment stations with the object of breeding varieties of corn which are especially rich in nitrogenous constituents, and this work has been attended with considerable success.

As the average figures show there is no appreciable difference in the composition of white and yellow corn, the variations which have been noted being smaller than are found in different analyses of either sort. When samples of the same grain are compared, whole corn and the unbolted meal made from it have the same composition, as the process of grinding neither takes from nor adds to the nutritive material present. The small variations between the whole corn and unbolted meal shown in the table are due to the fact that the figures are the average of many analyses of different samples. When the corn meal is bolted, about one-eighth of the original grain is removed, this material consisting chiefly of the cellulose of the skin. The removal of this material of course increases the proportion of the other materials present, and in this way it may be seen that the bolted corn meal is richer than the unbolted in nutrients other than crude fiber. Hominy, samp, and granulated corn meals resemble each other in composition, such differences as those indicated in the table being no greater than might be expected in a number of individual samples of either food material. In the manufacture of these corn products, the skin and germ have been removed and with them most of the crude fiber and considerable of the fat and mineral matter of the original grain. It might seem that in thus removing the fat and ash the food value would be decreased. This is only true in a measure, for it must be remembered that the proportion of carbohydrates, which are valuable nutrients and have the same functions as fat in nutrition, is increased. If a person lived exclusively on corn meal, the loss of the mineral matters might be serious, for a certain amount is necessary for the proper nourishment of the body. However, there is every reason to believe that the ordinary mixed diet contains a sufficient amount of the different ash constituents.

From the manufacturer's standpoint the removal of the germ does not represent a loss, as it is used for the manufacture of gluten feeds—so important for live stock—and corn oil, which has many industrial uses and is utilized to some extent as a salad oil and as a culinary fat. Cooking tests made in the home economics department of the Ohio State University showed that products in which corn oil was used as part of the shortening were of excellent quality, flavor, and appearance. Culinary fats are on the market which are claimed to be corn products, and studies carried on at the Connecticut State Experiment Station show that they contain corn oil as their characteristic constituent, the oil being stiffened with a harder fat.

The fine corn flour sometimes seen in American markets is granulated corn meal ground to the finest powder. What is called corn flour in England is known in the United States as cornstarch, and is the practically pure starch separated from the endosperm by special processes. It is commonly used for thickening puddings, sauces, etc., and in other ways, and has practically replaced arrowroot and the fine-grained tropical starches in invalid cookery.

The liquid glucose known as confectioners' glucose, or sometimes as mixing glucose, is a thick colorless liquid when well made, and is prepared in large quantities by inverting cornstarch, usually by boiling it with dilute hydrochloric acid and refining and evaporating the product. The liquid glucose sold for table purposes is often flavored with caramel or other materials and frequently contains added cane sugar.

Starch sugar or solid glucose is made in much the same way as the liquid product except that the treatment with acid is continued until practically all the starch is inverted. Although the liquid glucose and the starch sugar are not as sweet as cane sirup and cane sugar, they are considered to be perfectly wholesome, when well made, and of definite food value.

These glucose products made from corn are much used in the manufacture of certain forms of confectionery, being better adapted for certain kinds than cane sugar as they do not so readily harden and crystallize. The manufacture and use of liquid glucose and starch sugar have been spoken of in earlier publications of the Department.[a]

As is shown by the figures in Table 3, wheat flour of average composition is richer in protein than old-fashioned corn meal and contains about the same proportion of starch and less fat, crude fiber, and ash. In composition granulated corn meal differs from wheat flour mainly in containing less protein and more starch. Generally speaking, it will be seen that corn products compare favorably as regards nutritive value with such a standard food product as wheat flour.

COOKING.

Cooking cereals improves them in many ways. If bacteria or molds have found their way accidentally into the raw grain they are destroyed or rendered harmless by the action of heat. Although they knew nothing of micro-organisms, the American Indians and many other primitive people usually parched their grain before storing it, and in this way sterilized it as satisfactorily for their purposes as do modern millers by kiln drying. Cooking develops palatable flavors in foods. In the case of cereals and other foods rich in carbohydrates, the flavors are doubtless due in large part to the browning or caramelization of these constituents. Cooking also changes the mechanical condition of grain foods so that they may be more conveniently eaten and more readily acted upon by the digestive juices.

Parching is one of the simplest methods of cooking grains, and also doubtless the method first adopted by primitive man. Simple parched corn, it is said, is still eaten in central Asia and is regarded as a very convenient form of food for travelers in that part of the world.

Some of the desirable changes which heat produces in grain are most satisfactorily brought about when water is present, and from time immemorial it has been customary to mix grain with water or milk when preparing it for human food. The indigestible fiber of the cell walls breaks down under the combined action of moisture and heat, and so the real nutritive materials of the grain are more accessible to the action of the digestive juices than would otherwise be the case, for mastication, even if long continued, does not break down the cell walls of raw grain as easily or completely as is the case after cooking. Under the action of the moist heat the starch grains expand or swell and become soft and more porous, while a greater or smaller proportion of the starch may undergo what is known to the chemists as hydrolysis and be transformed from a substance insoluble in water to others which are readily dissolved. When there is no water present, as in parching, or when the water is very largely removed, as in baking or roasting, the starch tends to turn brown in color and acquires a pleasant toasted taste. In this process dextrin is formed, and as a whole these changes are akin to those noted in the caramelization of sugar.

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[a] U. S. Dept. Agr. Yearbook, 1905, p. 241; Farmers' Bul. 93.

Little is known regarding the changes which take place in the protein and fat during the cooking of corn, but they are doubtless much the same as with other foods, protein being coagulated by heat and fat broken down to some extent into simpler bodies if the heat is intense or long continued. The amount of water which corn meal and other corn products require in cooking varies considerably, the fine meal, for instance, absorbing less water than the coarse.

The proportion of water in a cooked dish is obviously determined by the amount of liquid originally present or added in preparation and the amount evaporated by the heat of cooking. Catherine A. Williams [a] studied the amount of water absorbed by a number of cereal foods and found that 100 grams of hominy sprinkled into boiling water, cooked until soft, and then drained, weighed 623 grams, or in other words had absorbed 523 grams of water. The original material contained 13 per cent water and the cooked 87 per cent. When 100 grams of a cornstarch preparation was cooked with water 618 grams of thick porridge or blanc-mange was obtained with a water content of 87 per cent as compared with 13 per cent in the original material used.

Corn meal is cooked in a great variety of ways, but most of the dishes fall under two general heads, namely, bread prepared by baking, and porridge or puddings made by boiling. In the case of the ready-to-eat corn breakfast foods the cooking has been done at the factory; the preparation at the factory usually consists in rolling or flaking and sometimes parching and flavoring the thoroughly steamed or boiled and softened grain.

The composition of corn breads and corn porridge and other cooked corn products is shown in Table 4 in comparison with uncooked corn meal and wheat bread. The flavor, food value, and other characteristics of the corn foods are taken up in the sections which follow the table.

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[a] Jour. Amer. Chem. Soc., 29 (1907), p. 574.

TABLE 4.—*Composition of cooked corn preparations, corn meal, and wheat bread.*

Kind of material.	Water.	Protein.	Fat.	Carbohydrates.		Mineral matters.	Fuel value per pound.
				Starch, sugar, etc.	Crude fiber.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Hominy, boiled	79.3	2.2	0.2	17.8		0.5	380
Hoecake	52.8	4.0	.6	40.0	0.2	2.4	885
Johnnycake	29.4	7.8	2.2	57.5	.2	2.9	1,385
Boston brown bread	43.9	6.3	2.1	45.7	.1	1.9	1,110
Corn breakfast foods, flaked, (partially cooked at factory)	10.3	9.6	1.1	77.9	.4	.7	1,680
Corn breakfast foods, flaked and parched (ready to eat)	7.3	10.1	1.8	77.2	1.2	2.4	1,735
Indian pudding	60.7	5.5	4.8	27.5		1.5	815
Cornstarch blanc-mange (made with cornstarch and water)	87.3	2.9	.1	9.5	....	.2	230
Parched corn	5.2	11.5	8.4	72.3		2.6	1,915
Popped corn	4.3	10.7	5.0	77.3	1.4	1.3	1,880
Hulled corn	74.1	2.3	.9	22.2		.5	490
Granulated corn meal	12.5	9.2	1.9	74.4	1.0	1.0	1,655
Wheat bread	35.3	9.2	1.3	52.6	.5	1.1	1,205

As has been stated, granulated corn meal and ordinary wheat flour are not very different in chemical composition, and the corn is often cheaper in price; nevertheless, wheat ranks far ahead of corn as a breadstuff, perhaps the most important reason for this being that wheat yields a lighter and more porous loaf with yeast or other leavening agent. This is due to the character of its protein, which consists largely of a substance known as gluten, so elastic in its nature that it stretches the dough into little pockets as the gases from the yeast expand within it. The heat of cooking hardens the gluten and so the finished loaf retains its porous structure. The only cereal which compares with wheat in the elastic and tenacious qualities of its nitrogenous constituents is rye. Corn contains no such gluten, and even when mixed with equal amounts of rye or wheat flour and raised with yeast, as in the old-fashioned "rye and Indian" bread, it does not give anything like as porous a loaf as either wheat or rye alone.

For the most part, therefore, corn breads are of the unleavened or flat bread type and are granular rather than porous. They are usually baked in thin loaves or cakes, and so the lack of gluten is less important. They do not keep as fresh as yeast-raised breads and should be eaten soon after baking. The simplest kind of corn bread is that in which the meal is mixed with water or milk and baked. Such were the cakes which the American Indians baked in the ashes of their camp fires or on a heated stone; such are the tortillas of Spanish America and the hoecakes of our Southern States (which get their name from the fact that the cake is sometimes baked on the blade of a hoe held over the coals), and the ash cakes or corndodgers, which, wrapped in a cabbage leaf, are baked in the hot ashes of the fireplace. Johnnycake and corn bread, popular in New England and other parts of the country, used to be prepared in much the same way, and were baked on a board before the fire and in later times in the oven; but nowadays they are usually made with part corn meal and part wheat flour and slightly raised by the addition of baking powder, eggs, etc. Other corn breads and cakes are made by mixing eggs, sugar, sour milk and baking soda, butter, lard, or other materials with the meal. Sometimes white and sometimes yellow meal is used in these preparations, each sort having its advocates who maintain that it is much superior to the other. As a matter of fact, analysis has shown that there is no constant difference in the composition of the two sorts of meal, and it seems equally certain that there is no uniform difference in flavor or cooking quality.

The famous Boston brown bread was originally a mixture of rye and Indian meal sweetened with molasses and lightened a little by the gases evolved by mixing sour milk and soda. It was made into large, thick loaves, which required long, slow cooking, such as was best obtained in the old-fashioned brick ovens. The weight of the loaves was fixed by law in Massachusetts in colonial times, and bakers were required to stamp their initials on the bread. Nowadays Boston brown bread is usually made with corn meal, rye, and whole-wheat flour, and is cooked by steam in small loaves in tightly covered tins. Combined with beans it has long been the orthodox Saturday-night supper or Sunday breakfast in many parts of New England. Such brown bread canned in small tins is a common commercial product. It is probably made like any other "Boston brown bread" except that it is cooked and sterilized in the sealed cans.

A sweet cake something like gingerbread is sometimes made by mixing molasses and spice into a johnnycake batter, and is an old-fashioned favorite in many homes. Projaca is a Servian corn bread in which eggs and cheese are mixed with maize meal, the dough covered with leaves and baked either in pans or in the ashes, somewhat like the ash cakes of our Southern States.

In Italy a considerable effort has been made to substitute maize wholly or in part for the more expensive wheat in making macaroni and other similar pastes. These foods, it should be remembered, which are used in the United States as an occasional substitute for vegetables and in similar ways, in Italy are eaten in large quantities as a staple food by all classes and often form the main if not the whole of a poor man's meal. Their advantage over flour, aside from their compactness, is that they are less liable to become moldy or to be attacked by insect enemies and may be easily and quickly prepared for the table with only the simplest cooking conveniences. While wheat is much better adapted to making these pastes, owing to its tenacious gluten, such goods made of mixtures of wheat and maize or of maize alone are by no means unpalatable. Their use however, is certainly not common, and their manufacture, which attracted considerable attention in Italy not long ago, seems never to have assumed much commercial importance.

Practical cooks differ in opinion regarding the relative values of the old-fashioned bolted and the new granulated corn meals in bread making. There is certainly a difference in flavor, due to the removal of the germ in grinding the granulated meals, but whether the distinctive flavor thus acquired is an improvement or not is largely a matter of individual opinion, and undoubtedly a person usually likes the sort to which he has been accustomed.

As to the texture of bread, the difficulty experienced with the newer types of meals often arises from the fact that recipes intended for the old-fashioned sorts are used without modification. Because they contain less fat the granulated meals require more shortening material than those which include the germ. They also absorb water less readily than the old-fashioned sorts, and for this reason some cooks prefer to scald the granulated meal before mixing it with the other ingredients. An extended series of tests carried on at Teachers' College, New York, as a part of the nutrition investigations of the Office of Experiment Stations, has shown that, when properly manipulated, bread from granulated corn meal is fully as light as that made from plain bolted meal, and that under such conditions the difference in texture and quality of the breads and other products from the two types of meal are not particularly marked.

The early colonial records tell us that the Indians pounded corn, often previously parched, to a coarse meal and made a sort of mush from it. Sometimes nuts, berries, beans, pumpkins, etc., formed part of the dish, while sometimes meat or fish were used much as the Scotch mix meat with oatmeal in their meat brose. It is not surprising that the colonists took kindly to corn-meal porridge, as it was similar to the dishes made from other cereals which they had known at home.

"Hasty pudding," or corn-meal mush, which may be made with either milk or water, is a dish which can be quickly cooked, as its name implies, though long slow cooking is generally conceded to yield a better dish. Good cooks always insist that the water must be vigorously boiling and that the meal must be slowly stirred in, a little at a time, in order that the mush may be smooth and of the proper consistency. Hominy and samp, which are much coarser than meal, require longer cooking, and for this reason are often considered less convenient than other similar cereals. The very coarse hominy is not an economical dish where cooking is done on a gas stove and fire must be kept especially for it, but in households where the range is hot all day a dish of it in a double boiler at the back of the stove will almost cook itself. Sufficient water is important in cooking hominy and samp, as the grain, if not constantly covered with water, becomes rather hard and dry. On the other hand, too much water makes the dish gummy and unattractive. To be properly cooked each grain of hominy, though soft, should retain its distinct form, as is the case with well-cooked rice. Old-fashioned meal and hominy made from corn which includes the germ have a more distinctive flavor than the products made from degerminated grain, and for this reason they are often preferred for porridge making, though the use of one sort or the other is, of course, entirely a matter of taste. A New England cookbook of one hundred years ago gives the following advice: "For Sunday morning in winter fry the hasty pudding that was left over from Saturday night's supper. Eat it with West India molasses or Muscovado sugar." Fried mush and fried hominy are still favorite breakfast dishes. They are also sometimes served with meat in the place of vegetables, as is also plain boiled hominy.

Corn-meal mush is so much used under the name of polenta in many parts of Italy that it may almost be called the national dish. Polenta is made much like hasty pudding, except that some grated cheese or lard or other fat is commonly one of its ingredients. With poorer people polenta often constitutes the bulk of the daily fare, while in more well-to-do families it is an accompaniment of meat dishes and other foods, and is served in a variety of ways, many of them worthy of a trial by American housekeepers.

Tamales, a Mexican corn-meal dish formerly little known to American cooks except in the southwestern United States, are now comparatively common. In making these, corn meal suitably prepared is mixed with meat or chicken and chili peppers or other seasoning, wrapped in corn husks and boiled until well cooked. So well known has this dish become that canned tamales are on the market.

Indian pudding, a favorite family dessert in this country, is made by mixing molasses, butter, spices, etc., with corn meal into a batter with milk or water. It used frequently to be boiled in a cloth like Christmas plum pudding, but now is more commonly baked or steamed in a deep dish.

Many cooks use corn starch for thickening sauces, etc., because it gives them a smoother consistency than flour. It also forms the basis of puddings, in which it is mixed with milk, sugar, eggs, etc. Such dishes are very nutritious and palatable, and are believed to be easily digested, which accounts for their use in invalid cookery.

Corn-meal gruel, a palatable dish once much more commonly prepared for invalids than at the present day, is cooked for such a long time and with such large proportions of water that the crude fiber of the corn meal is quite completely broken down and the starch very largely converted into a smooth, almost jelly-like condition.

Though the proportion of water may be higher in mush or porridge than in corn bread, yet such foods are nutritious and may be readily combined with other dishes to form a palatable and wholesome diet.

HULLED CORN.

Hulled corn, or lye hominy, is prepared by steeping the kernels in hot water which contains lye, or sometimes simply a small bag of wood ashes, until the hulls are loosened or softened. The corn is then soaked in plain water until the lye is washed out and then boiled until it is soft. When it is eaten in milk as a breakfast dish or used in other ways, its distinctive flavor makes it a food much liked in many families. One hundred years ago it was a common custom for housewives to prepare hulled corn for the use of their families, but the process is time-consuming, and it is now commonly purchased from dealers, who often make a specialty of supplying it. Lye hominy is a common product in Washington and Baltimore markets, and the hulled corn vender is well known in many New England towns and elsewhere in the northern United States. A number of brands of canned hulled corn are on the market which differ in no appreciable degree from the freshly prepared product. As the figures in Table 4 show, hulled corn has much the same composition as boiled hominy. It owes its distinctive flavor in considerable measure to the treatment with lye.

CORN BREAKFAST FOODS.

There is at the present time a great number of proprietary breakfast foods on the market, some of which are ready to eat, while others need only a little cooking, and so are easier to prepare for the table than the old-fashioned meals or grits made from similar grains. A number of these breakfast foods are made from corn. In the case of the partially cooked and ready to eat brands the processes of manufacture are apparently the same as with similar foods made from other grains. Selected grain, carefully freed from all impurities, is steamed or cooked until it is soft, then flaked or rolled by passing it through heavy rollers, and dried. Sometimes the flakes are parched with or without the addition of malt. Variations in the process of manufacture give the granular preparations and other varieties with which we are all familiar. Corn breakfast foods, like other goods of this type, are very commonly marketed in packages. The food value of these corn preparations and other breakfast foods has been discussed in an earlier bulletin of this series.[a] In general it may be said they are comparatively concentrated foods, as they contain little water, and are quite similar to corn meal in chemical composition.

POP CORN AND PARCHED CORN.

Special varieties of corn with hard, small kernels are used for popping. Pop corn was formerly sold on the ear, but now it can be bought already shelled, in bulk, or packed in small cardboard boxes. Such corn has been carefully kiln-dried and perhaps pops more evenly than the home-dried product. In the popping, which takes place when the kernels are exposed to intense heat like that from a good bed of coals, the endosperm expands and pops or bursts white and crisp through the torn skin. It was formerly supposed that this bursting was due to the sudden expansion of the fat in the grain, but it is now known that it is caused by the sudden expansion of the cell moisture into steam. In pop corn the cell walls are very firm and hard and do not burst until the pressure is quite considerable. Ordinary varieties of corn, in which the cell walls are softer, when treated in the same way, expand and sometimes burst more or less, but do not have the characteristic popped appearance.

During popping, corn loses considerable water, and so it contains a larger proportion of nutrients than the original grain. Chemical changes take place also in the nutrients themselves, though they are not very well understood. Part of the carbohydrates are undoubtedly browned or caramelized, and it is believed that the peculiar flavor of popped corn is due in a measure at least to this fact. It is a matter of common experience that the flavor and texture of popped corn deteriorates if it is kept for any considerable time after popping. Apparently the loss of crispness is due to the fact that the freshly popped corn is so very dry and porous that it readily absorbs moisture from the air.

Popped corn is usually eaten out of hand and can hardly be called an important food product, though the total amount used in the United States is large—about 300 carloads annually, it has been estimated. Puddings and other foods are sometimes made from popped corn, and popped corn and milk is an old-fashioned dish which is wholesome and may be made to accord with modern habits by using it as a breakfast cereal. Popped corn is, however, most commonly eaten with salt and butter or made into a sort of confectionery with molasses or sugar.

Popped corn resembles other corn products in composition, except that it contains less moisture. Its very porous structure makes it a comparatively bulky food. So far as can be learned, its digestibility has not been studied experimentally, but there is no reason to suppose that it is not easily and thoroughly digested.

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[a] U. S. Dept. Agr., Farmers' Bul. 249.

It is often stated that pop corn is used in large quantities in the manufacture of breakfast foods and for the adulteration of flour, but both these statements are denied on good authority.

Parched corn, made from ordinary varieties which expand but do not burst on heating, is eaten to a limited extent out of hand. As the figures in Table 4 indicate, it does not differ very materially in composition from popped corn.

Infusions of parched corn or of "browned" corn meal or parched brown bread crusts are old-fashioned coffee substitutes which many persons consider among the most palatable cereal coffees. The food value of "corn coffee," like that of all similar beverages, depends very largely upon the sugar and cream added to it, for the small quantity of caramel or other browned material which it contains in solution is not of much importance, and 99 per cent of the infusion is water.[a]

DIGESTIBILITY OF FOODS MADE FROM CORN.

The real value of any food material depends not only on the amount of nutrients which it supplies but also on the proportion of these nutrients which the digestive organs can convert into such a form that they may be absorbed into the blood and made available for the nourishment of the body—in a word, upon digestibility. The thoroughness of digestion of the more common food products has been carefully determined. A number of digestion experiments have been made with corn, the first of these being perhaps that reported by Rubner about thirty years ago. He found that a man on a diet of corn-meal porridge, with a little butter, meat extract, and cheese, retained in the body 85 per cent of the protein, 83 per cent of the fat, 97 per cent of the carbohydrates, and 70 per cent of the ash which the food supplied. Somewhat later Malfatti, an Italian, studied the digestibility of maize porridge (polenta) eaten with cheese and found that 93 per cent of the protein, 91 per cent of the fat, 98 per cent of the carbohydrates, and 81 per cent of the ash were digested. Somewhat lower values were found when the polenta was eaten without the cheese. In more recent Italian experiments with polenta, much the same results were obtained, though the values found for protein were rather lower. Macaroni and similar pastes made wholly or in part of corn meal, though somewhat more digestible than the corn-meal mush were found to be a little less digestible than similar foods made from wheat.

Harcourt[b] at the Ontario Agricultural College and Experimental Farm studied the digestibility of a number of breakfast foods, including corn-meal mush. According to his experiments, 74 per cent of the protein and 99 per cent of the carbohydrates of corn-meal mush are digested when it forms a part of a simple mixed diet.

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[a] See also U. S. Dept. Agr., Farmers' Bul. 249, p. 33.

[b] Jour. Soc. Chem. Indus., 26 (1907), p. 240.

The digestibility of corn-meal mush or "hasty pudding" and boiled hominy has also been studied recently at the Maine Experiment Station. The hasty pudding was made by stirring meal into salted water and cooking it in a double boiler. It was found that in the case of a mixed diet containing considerable quantities of hasty pudding 89 per cent of the total protein and 99 per cent of the carbohydrates were digested, while 97 per cent of the energy of the diet was available for the body. When the hasty pudding was eaten with a little milk or sugar and constituted a considerably larger proportion of the diet, 82 per cent of the protein and 99 per cent of the carbohydrates were digested and the quantity of energy available was the same as before. The calculated values for the digestibility of hasty pudding alone were: Protein 73 per cent, carbohydrates 98 per cent, and available energy 93 per cent. The experiments of similar nature which were made gave for hominy as a part of a mixed diet, for hominy with milk and sugar, and for hominy alone practically the same values as were obtained for the mush. From all the experimental data the conclusion may be fairly drawn that the nutritive ingredients of dishes made by cooking corn in water are well assimilated.

The digestibility of corn breakfast foods has been studied at a number of the experiment stations, particularly in connection with the cooperative nutrition investigations of the Office of Experiment Stations. As has been pointed out in an earlier bulletin of this series,[a] which discusses the digestibility and nutritive value of cereal breakfast foods as a whole, 74 per cent of the protein, 90 per cent of the fat, and 99 per cent of the carbohydrates of corn breakfast foods are assimilated, while 95 per cent of the energy is available. These values, it will be seen, are very similar to those given above for corn-meal mush, etc.

An extended series of experiments on the digestibility of corn bread of different sorts, including hoecake, johnnycake, and Boston brown bread, was also carried on at the Maine Experiment Station. In every case the same sort of granulated corn meal was used. The brown bread was made of equal parts of corn meal and wheat flour mixed with milk, molasses, baking powder, and a little salt. It was steamed in cans for four hours. The johnnycake was made of equal parts of corn meal and wheat flour, with suitable quantities of milk, sugar, baking powder, and salt. Neither flour nor baking powder was used in the preparation of hoecake. The meal was stirred into boiling water until a thick pudding was formed, which was immediately spread in thin sheets upon hot well-greased iron plates a baked at once. For purposes of comparison, digestion experiments were also made with wheat-flour bread. The foods under consideration were eaten with milk and sugar, or sirup in the case of hoecake—this ration being termed a simple diet—and as a part of a more elaborate mixed ration which also included canned peaches and meat.

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[a] U. S. Dept. Agr., Farmers' Bul. 249.

The average figures which were obtained for the different corn-bread rations with the healthy young men who served as subjects and the calculated values for the bread alone are shown in Table 5, which also contains, for purposes of comparison, the results of the similar study with wheat bread made from standard patent flour.

TABLE 5.—*Average digestibility of corn bread of different sorts compared with wheat bread.*

Kind of food.	Entire ration.			Corn products alone.		
	Protein.	Carbohydrates.	Heat of combustion of digested material.	Protein.	Carbohydrates.	Heat of combustion of digested material.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Hoecake in mixed diet	90.0	98.8	92.6			
Hoecake in simple diet	87.0	98.7	93.7	77.1	98.6	93.8
Hoecake with sirup	84.4	99.2	95.5	78.8	98.7	94.0
Johnnycake in mixed diet	90.1	99.3	93.9			
Johnnycake in simple diet	89.6	98.7	93.8	86.3	98.9	93.5
Boston brown bread in mixed diet	89.5	99.4	92.9			
Boston brown bread in simple diet	87.4	98.7	93.5	83.0	98.6	93.4
Wheat bread in mixed diet	92.6	99.0	98.2			
Wheat bread in simple diet	89.2	98.9	94.0	85.6	98.9	94.0

The data in the table show the digestibility of the nutrients of the total diet, including the given corn product, and that of the nutrients of the corn product itself when thus eaten. The results as a whole are very favorable indeed. In all the experiments with corn bread the carbohydrates of the corn were almost completely utilized by the body. The figures for protein vary somewhat with the different products, indicating that the method of preparation may have some influence upon the thoroughness of digestion. It was least thoroughly digested in hominy and hasty pudding (see p. 24). The figures for proteïn of hoecake, and hoecake with sirup, are a trifle larger. On the whole the experiments indicate that the protein of corn is slightly less thoroughly digested than that of wheat, but the difference is too slight to be of much practical consequence. As a matter of fact, in the case of johnnycake and brown bread, which are practically breads made of corn meal alone or mixed with wheat or rye flour, the protein was as thoroughly digested as that of yeast-raised bread from white wheat flour, with which experiments were made for comparison.

By comparing the percentages of digestibility of corn alone with those found for the total simple diets and mixed diets it will be seen that its protein is in every case less thoroughly digested than that of the total diets and that the protein of the total simple diets is less thoroughly digested than that of the mixed diets. These facts are in accord with observations in many similar experiments, and are believed to indicate that the digestibility of protein depends somewhat upon the proportion of protein to other nutrients in the diet. The Italian experiments in which the protein of cheese—a material rich in protein—and corn porridge were more thoroughly digested than that of corn porridge alone or with butter, strengthen this belief.

All the above-mentioned tests referred to thoroughness of digestion, and give no information with respect to the ease or comfort with which food is assimilated. The time which elapses between the eating of food and the excretion of the undigested residue of it does not vary much with the ordinary foods, and the rapidity of digestion therefore usually has reference to the length of time which food remains in the stomach. Although to a healthy person this is probably a matter of little moment, it may be a question of considerable importance with invalids. Unfortunately it is very difficult to obtain definite information on such matters. Beaumont, in his famous observations on the Canadian trapper with a gunshot wound in his stomach, found that corn bread remained in the stomach three hours and fifteen minutes and ordinary wheat bread three hours and thirty minutes. In this connection, however, it must be remembered that starch, the main ingredient of cereal food, is digested in the intestines rather than in the stomach and that the way in which such observations as Beaumont's should be interpreted is a matter on which there are differences of opinion. Common experience, however, it may be fairly claimed has shown that well cooked corn products are usually digested without distress or disturbance.

WHOLESOMENESS OF CORN.

There are all sorts of popular notions about the effect of corn on the body. Thus, one occasionally hears it said that it is indigestible and unfit for persons of weak digestion. Old-fashioned corn meals in which the skin was imperfectly bolted out and the fat of the germ which readily becomes rancid, was retained, may have been digested somewhat less easily or less thoroughly than some other cereal foods but it does not seem probable that the finely granulated corn meals now commonly found on the market which contain little save the starch and protein of the grain would tax the digestive organs very severely. Experiments have certainly shown that such corn meal is very well assimilated. Foods containing coarse material like the bran of cereals are believed to stimulate the movement of food through the intestines and so to counteract any tendency to constipation. From this standpoint the use of the coarser meals has an advantage which in most cases will doubtless make up for any differences in ease or thoroughness of digestion.

The digestibility of any ordinary cereal food is increased by thorough cooking, as this tends to break down the crude fiber of the cell walls and changes the physical or chemical nature of the starch so that it is more readily acted upon by the digestive juices. The more cellulose a food contains the more important it is that the cooking should be thoroughly done, and so the desirability of properly cooking corn meal is obvious.

Corn is frequently spoken of as a good winter food, but as too "heating" or "heating to the blood" for summer. Just what these expressions mean is not easy to say. Carefully conducted experiments have shown that as a rule the consumption and digestion of carbohydrates and fats does not materially increase the output of the body heat, but that protein does cause an increase in the amount radiated or otherwise given off by the body. Generally speaking, however, in the few experiments which have been made with man this increased liberation of heat has not been accompanied by a sensation of warmth. Corn is not a typical proteid food, as its protein content is not over 10 per cent, so it would hardly cause an appreciable increase in the output of heat from the body as compared with wheat or other common foods also supplying the different classes of nutrients in reasonable proportion.

Corn is rich in fat and carbohydrates and so is a fattening food, as its extended use in the feeding of farm animals abundantly demonstrates. Fat is known to protect the body from extremes of temperature and so it may be that corn has been spoken of as a heating food, particularly valuable in the winter diet, on account of its fat-producing qualities rather than because of any specific heat-producing properties.

The term "heating foods" seems often to mean simply hearty foods; that is, those which because of their bulk, the length of time they remain in the stomach, or for other reasons delay the normal recurrence of hunger for a longer time than usual. Some corn dishes, like corn-meal cakes with sirup, or the crackling bread of southern cooks which contains the pork cracklings or scraps left after lard is rendered, are unquestionably hearty foods, but no more so than similar dishes made from other cereals. Certainly simple corn breads and other simple corn dishes do not seem to particularly merit this designation.

In this connection it is interesting to note that corn has always been a more important foodstuff in the southern United States, Mexico, and the Mediterranean regions than in corresponding northern egions, even where it is a common market commodity, and this would certainly indicate that there can be no reason for supposing that cold weather is more appropriate for the use of corn foods than warm. The most reasonable deduction from available data is that the way in which corn dishes are prepared and cooked, and the foods with which they are combined are more important factors than climate in regulating the use of these foods, and that, rightly used, corn bread and other corn dishes are wholesome at all seasons.

A curious and often fatal disease, which has at times been very prevalent in Italy and the Balkans, was formerly believed to be due to the large quantities of maize eaten by the poor of these regions. This disease, which in Italy is called pellagra, begins with eruptions on the skin and in later stages is attended by serious intestinal and cerebral disturbances, and often terminates fatally. Carefully conducted investigations have shown that this disease is not due to the maize itself, but to a mold or fungus which readily grows in the grain when it is stored in damp places, as is commonly the case in these regions, and which in its growth develops poisonous substances. Fortunately, this fungus has never infected corn in the United States, but the evils which attend such infection emphasize the need of taking adequate measures to prevent it and show the advantages of thoroughly sterilizing the grain, as by kiln-drying, before it is used by either man or animals, for when once started such an infection is very difficult to check.

The occasional digestive disturbances which are noted after eating corn and corn products are of the same sort as occur with other foods, and may be due to overindulgence, to some personal idiosyncrasy, or some similar cause, and may be left out of account in considering the general question of the wholesomeness of this grain. That it is wholesome and well suited to its numerous uses as a food product is abundantly proved by its long-continued use under a great variety of circumstances and conditions and the high opinion in which it has always been held. Scientific investigations have abundantly justified the popular conclusions on the subject.

RAW CORN AS AN ARTICLE OF DIET.

Any extended study of questions concerned with the selection and use of foods shows that such topics have received much attention since earliest times, and that many widely divergent and contradictory theories have been proposed. One of the theories which has again attracted attention is that cooking decreases the value of food. Regarding corn and other cereals, the upholders of this theory say that not only is the healthy body able to digest them raw but also that the heat of cooking greatly decreases their nutritive value by destroying the "vital principle" of the grain. Exactly what this "vital principle" is or what effect it has on the body is not explained

Indeed, aside from the possible value in some cases of the ferments present in the raw food, there is no experimental evidence to support the theory nor does physiological chemistry give any ground for believing it. Persons of healthy digestion can undoubtedly eat raw cereals in reasonable amounts with impunity, provided the materials are thoroughly masticated and are free from accidental contamination from dangerous micro-organisms, which often accompany dust and dirt and are conveyors of disease. Raw starch is digested in the body, but it is much more difficult to break down the cell walls protecting the starch in raw grains than it is when they have been cooked.

In cases of constipation the quantity of crude fiber and the coarse, mechanical condition of this raw corn and other similar cereal products may sometimes have a beneficial effect, but judged by composition and digestibility they can certainly possess no advantage over the cooked foods. To forego the advantages produced by cooking seems to involve a useless waste of digestive energy for persons of delicate digestion, if not for all.

PLACE OF CORN IN THE DIET.

According to commonly accepted dietary standards, the daily food)f a man doing light to moderate muscular work should provide about).23 pound of protein for the building and repair of his body tissues ınd other uses and 3,000 calories of energy for his bodily activities.)f course, as muscular work increases or decreases, these quantities,)articularly the energy, should be correspondingly increased or lecreased. Women on an average are smaller in stature than men nd so require relatively less food, as do also children. The ideal iet is one which supplies the right quantities of nutrients in the roper proportion and in an appetizing and attractive form, while at he same time it is reasonable in cost.

About 3 pounds of corn meal would furnish the protein called for y the above-mentioned standard, but would supply with it about ,830 calories of energy or more than one and one-half times as much s is required. If, on the other hand, the amount should be so duced that only the desired energy is supplied, the protein furnished ould be only about two-thirds of the assumed requirements. Thus, is evident that corn contains too little protein in proportion to its ergy-yielding constituents to be a well-balanced food when used one. Even if it furnished the proper proportions of protein and ergy, corn would hardly be an ideal food for use as the sole article diet, for it would be very bulky, 3 pounds of corn meal, when oked into bread or mush, representing a rather formidable amount food. Moreover, corn, or, indeed, any other single food, would not ng seem appetizing to a person accustomed to a varied diet, and it an accepted physiological fact that appetizing qualities have much to do with stimulating the activity of the digestive organs. The fact that, under stress of need, people have lived for considerable periods on corn alone does not prove that such a diet is to be recommended, but rather that the body has great powers of adapting itself to an emergency. In the United States it has always been the custom to combine corn with other foods rich in protein, as such combinations as mush and milk, Boston brown bread and baked beans, and hominy and fried chicken testify, and these combinations are more rational than either food used alone. The Italians often mix cheese with corn in making polenta or mush, and thus increase the protein content, as well as vary the flavor of the dish. Milk, which contains considerable protein, is also commonly used with corn meal by the peasants of southern Italy; and, indeed, it may be said to be a general rule with corn as with other carbohydrate foods that the attempt is universally made to provide by proper food combinations the protein which the body seems to demand.

Among the negroes and mountain whites of the southeastern United States large quantities of corn are used in combination with salt pork sirup or molasses, milk, some wheat flour, and more or less green vegetables and fruit. The common designation "hog and hominy points out the leading features of this diet and suggests its fault. Salt pork, which consists almost wholly of fat, adds very materially to the energy value of the diet without adding much of any protein, and none of the other foods supply enough of this constituent to make the diet well balanced. Among 70 families in the mountain regions of eastern Tennessee the average diet yielded 0.18 pound of protein and 3,600 calories of energy per man per day, which is 77 per cent of the protein and one-fifth more than the energy suggested by the dietary standard referred to above (see p. 29). In this diet, which was cooked and served in the simplest ways, corn supplied about 35 per cent of the protein and 30 per cent of the energy. Similar conditions were noted in the families of negroes in Alabama, and also studied in connection with the nutrition investigations of the Office of Experiment Stations. Taken as a whole, the people who live very largely on such a diet do n seem to be in as robust physical condition, as well nourished, or as productive of efficient labor as others who are more fortunately situated. How much of this can be attributed to a lack of protein and too great a proportion of fats and carbohydrates and how much to poor cooking, monotonous fare, and generally unhygienic living conditions it would be hard to say. From the results of the Alabama studies, however made at and near Tuskegee, and from general sources of information it seems certain that better health and more efficient work attend improved conditions of living and diet. When the corn was more generously supplemented by milk, eggs, meat, cowpeas, and other legumes, and the foods were better prepared, a general improvement was noted in the Alabama families, as, indeed, it generally is when a better and more generous diet is made possible for a family or community long accustomed to opposite conditions.

With a mixed diet of meat, eggs, milk, vegetables, fruit, etc., such as is found in homes in the United States, the exact proportion of protein to energy in each individual food material is of less consequence than when the food consists of two or three materials only. If breakfast with its bread and cereal yields too little protein this will ordinarily be offset by dinner in which meat, custard, cheese, beans, lentils, or similar foods will probably be used. In such a diet as this, corn ordinarily is used in place of some other cereal which it approximates in composition, and the diet as a whole is usually well balanced.

One good feature about corn meal is that it can be made into an appetizing bread perhaps rather more easily and quickly than wheat flour. During the civil war large quantities were used by the soldiers of both armies and it was found that, although the meal did not keep as well as wheat flour, a palatable corn cake could be made from it under almost any conditions, whereas it required some considerable experience and skill to make even fairly edible wheat bread with the simple utensils which were oftentimes the only ones available. For the same reason campers and others who live for any length of time away from a base of supplies not infrequently prefer corn meal to wheat flour, especially when it has been thoroughly kiln-dried (see p. 12). It has been said that the name johnnycake is a corruption of ourney cake, and that corn bread was so called because it could be o easily prepared on the road. In the ordinary household with its well-equipped pantry and kitchen this feature is not a matter of as much importance as it would be under other conditions, but even ere corn bread may often help the housekeeper in an emergency more easily than could wheat biscuits.

Corn meal, when used for bread, cakes, porridge, puddings, etc., nd hominy and other corn foods are cheap and apparently well-igested sources of both protein and energy, and although like other ereal foods, not well fitted to supply a suitable diet if used alone, hese corn dishes combine readily with other materials to form a ation which is in accord with accepted dietary standards, and which at the same time palatable and wholesome. The corn dishes which ay be easily prepared are very numerous, and this important foodstuff might well be used more frequently than is at present the case in e average American home, to give an inexpensive variety to the iet as well as for its generally valuable qualities.

PECUNIARY ECONOMY OF CORN.

The relative economy of different food materials depends not merely on the price per pound but also on the amount of digestible nutrients which a given sum will purchase. Ten cents spent for potatoes will yield a much larger bulk of food, for instance, than the same sum spent for flour, but so great a proportion of potatoes is water, or juice, and inedible skin that the body actually obtains less than half as much protein and energy as from 10 cents' worth of wheat flour.

Table 6 compares corn and a number of other foods as sources of digestible protein and energy when valued at certain assumed averag prices per pound.

TABLE 6.—*Cost of nutrients of corn and of other food materials at certain assumed pr*

Kind of material.	Price per pound.	Cost of 1 pound of protein.	Cost of 1,000 calories of energy.	Amount for 10 cents.				
				Total food material.	Protein.	Fat	Carbo-hydrates	Energy
	Cents.	*Dollars.*	*Dollars.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calor*
Corn meal, granulated...	2.5	0.32	0.02	4.00	0.31	0.07	2.96	[illegible]
Do.................	3.0	.44	.02	3.33	.23	.06	2.48	[illegible]
Hominy................	4.0	.62	.02	2.50	.16	.01	1.97	[illegible]
Samp.................	5.0	.78	.03	2.00	.13	.01	1.57	[illegible]
Corn breakfast food, flaked and parched....	13.0	1.73	.08	.77	.06	.01	.60	[illegible]
Wheat flour............	3.0	.31	.02	3.33	.32	.03	2.45	[illegible]
Wheat breakfast food...	7.5	.73	.04	1.33	.13	.02	.98	[illegible]
Wheat bread...........	5.0	.64	.04	2.00	.16	.02	1.04	[illegible]
Oatmeal...............	4.0	.29	.02	2.50	.34	.16	1.66	[illegible]
Beans, white, dried.....	5.0	.29	.03	2.00	.35	.03	1.16	[illegible]
Corn, green, canned.....	10.0	4.21	.23	1.00	.02	.01	.18	[illegible]
Potatoes, 60 cents per bushel...............	1.0	.67	.03	10.00	.15	.01	1.40	[illegible]
Beef, sirloin.............	20.0	1.28	.20	.50	.08	.08	....	[illegible]
Beef, shoulder clod......	9.0	.57	.13	1.11	.18	.10	....	[illegible]
Pork, roast, lean........	12.0	.92	.10	.83	.11	.19	....	[illegible]
Pork, salt, fat...........	12.0	6.67	.03	.83	.02	.68	....	[illegible]
Butter................	25.0	25.00	.07	.40	....	.32	....	[illegible]
Cheese................	16.0	.64	.08	.63	.16	.20	.02	[illegible]
Milk, 7 cents per quart..	3.5	1.09	.11	2.85	.09	.11	.14	[illegible]

The first column of figures in the table shows the assumed price p pound, the second and third compare the foods at these assumed pri as sources of protein and energy, while the remaining columns sho the amounts of nutrients and energy which 10 cents expended for th foods at the stated prices per pound would furnish.

Of the foods included, corn meal, oatmeal, and wheat flour, it w be seen, are the cheapest sources of protein with the exception dried beans, and also of energy with the exception of potatoes and s pork. Corn meal sells at a lower price than hominy or samp; and they all have practically the same composition and so furnish nea the same amounts of protein and energy per pound, it is obvious th the meal is more economical than these products. The speci prepared corn breakfast foods included in the table are more th twice as expensive sources of protein and energy as hominy or samp, and still more expensive as compared with corn meal.

From this table it would appear that the low-priced wheat flour is in reality fully as cheap as corn meal, and this is undoubtedly true when these foods are brought under ordinary market conditions in most parts of the country. In remote sections, however, such as the mountain districts of our southeastern States, where climate and other conditions are favorable to the production of corn, where milling facilities are primitive and communication with other regions difficult, it requires a smaller outlay for a man to furnish his family with corn than with wheat. In the dietary studies made among the southern mountaineers already referred to, 20 per cent of the total food was in the form of corn and the total cost of the food per man per day ranged from 3 cents to 16 cents, the average being 9 cents. In 20 studies made in an especially remote district of eastern Tennessee the average cost was only 7 cents, and with these families corn was also the staple food. Whatever one may think regarding the ultimate physiological and sociological value of such a diet, there can be no two opinions regarding its immediate cheapness.

Throughout Europe more intensive cultivation is required than in the United States, and wheat commands relatively a much higher price than corn where the latter is a market commodity. There is also a difference on the side of wheat in the United States, but it is less than it was formerly, for during the last fifty years the price of corn has risen while that of wheat has decreased. Pereira and Lee,[a] writing as early as 1850, reported that a bushel, or about 60 pounds, of good corn could be bought for about 56 cents, and that a pound of this would yield from 2.5 to 3 pounds of food, so that "if an individual could live on this alone his annual expense for food would be $3.65, or say $15 for a family of five." According to the dietary standards previously referred to it would require nearly 3 pounds of corn to furnish the necessary protein; but even so, a man in 1850, if it had been possible for him to subsist on corn alone, would have expended but 3 cents a day, or $10.95 a year, and at present average prices for corn such a diet would cost about the same. These calculations are interesting as illustrations of the relation between the cost and nutritive value of an important foodstuff, but, of course, do not imply that it would be possible or desirable for a person to live on corn or any other single foodstuff.

Food materials of nearly all kinds are more expensive in Europe than in the United States, and the diet of many persons, particularly those of limited means, are very much less generous or varied there than here. Rye bread and milk or cheese with some vegetables constitute the bulk of the food throughout large regions of northern Europe. Corn meal from the United States could be sold in these regions even more cheaply than the rye or other cereals so extensively used at present, and both the United States and the European governments have tried to introduce corn as a substitute for, or a supplement to, other cereals; but in spite of its cheapness the people have not taken to it any too kindly, in part, doubtless, because the homegrown corn with which they are familiar is of inferior quality, and in part because they are ignorant of the proper ways of preparing and cooking it and do not understand how to make from the corn dishes which are similar to those which they prepare from other grains. Such difficulties, however, should not be insurmountable, for the use of corn has become widespread in China and other parts of the East, and the differences in dietary habits which were overcome before this was possible must have been greater than those which exist between the Europeans in question and ourselves. It would be of mutual advantage to American producers and European consumers if such difficulties could be set aside, and it seems probable that eventually this will be accomplished.

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[a] Treatise on Food and Diet. New York, 1850, p. 161.

GREEN CORN.

Green corn or sweet corn is commonly spoken of as a distinctively American dish, but this is not really the case, although the cultivation of certain varieties for use as green vegetables is much more common here than elsewhere. Green corn is little known in the northern and western parts of Europe, though it may be found, for instance, in the large London markets, and canned corn is obtainable in many European cities. In the Balkan regions, however, the unripe ears are roasted and considered a delicacy as with us. In his report for 1901 the commissary-general of the United States Army states that the American troops sent to the relief of Peking obtained green corn from the natives along the line of march and notes that the Chinese frequently cooked it on the cob, though they regard it more as a fruit than as a vegetable. In Africa and Australia, where corn is extensively grown, the unripe ears are used as food, though not as generally as in the United States and Canada. A recent publication[a] notes the extended use of both green and ripe corn by African natives who cultivate corn and a number of other food plants. The article further states that they are accustomed to chew the green succulent corn stalks, which are sweet, as they do sugar cane.

As everyone knows, the special varieties of corn which are characterized by a sweet taste are most prized for use as a vegetable, and analysis shows that these varieties actually contain considerab more sugar than corn raised for other purposes. Taking the average of a number of analyses, 5 per cent sugar and 15 per cent dextrose and other soluble carbohydrates have been reported in ripe sweet corn as compared with 3 per cent sugar and 3 per cent dextrose and other soluble carbohydrates in the varieties of corn commonly raised for feeding purposes and for manufacture into meal. The Massachusetts experiment station has reported 0.8 per cent cane sugar and 0.4 per cent glucose, making 1.2 per cent total sugar as the average amounts present in a large number of samples of sweet corn gathered when just ready for the table. Much higher values than these have been noted in individual samples.

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[a] Jour. Trop. Med. London, 10 (1907), p. 157.

Corn on the cob is not very convenient to serve or eat and this method of cooking it would doubtless have been abandoned long ago if cutting the kernels from the cob before cooking did not materially modify the flavor. In household practice it is usually more convenient to boil the ears, but in old-fashioned fireplaces or at camp fires roasting is a deservedly popular method of cooking corn. Green corn, like other vegetables, is at its best when freshly gathered. It is commonly believed that corn which has been picked any considerable time is not as sweet as that which is freshly gathered. That this is actually the case was proven by recent investigations by the Bureau of Chemistry of this Department, which showed that sugar disappears from the kernels very rapidly after the ear is separated from the stalk, and within 24 hours after harvesting, if exposed to ordinary temperature, is almost entirely absent. The season of corn is more nearly limited to the season of maturity in a given region than that of almost any other common vegetable, for it can not be stored for any considerable time in good condition, even with modern appliances, and corn grown in warm climates and shipped long distances to our winter markets is very expensive and rather uncertain as to its quality. Corn, however, may be readily canned on a commercial scale, and when this is properly done it retains many of its desirable qualities. It is not surprising, therefore, to find that canned corn is one of the most popular canned vegetables. In canning corn the process is much the same as that followed with other vegetables. The kernels cut from the cob and salted are sterilized in sealed cans, the aim being to apply the heat in such a way and for such a time that the micro-organisms causing decay will be destroyed, while at the same time the process is so regulated that the flavor and appearance are changed as little as possible. For a long time the attempts which were made to can corn on the cob were not very successful, but methods have been improved, and corn canned on the cob is becoming an important article of commerce.

Succotash, a mixture of unripe corn and beans cooked together, is a dish which was borrowed, name and all, from the Indians, and has been a favorite since colonial times. To vary their winter diet, the colonists often cooked dry ripe corn and beans together, but such a dish does not possess the palatability of that made from green corn. Corn with tomatoes is another mixture which many persons like and which is quite commonly served. Canned corn with tomatoes is on sale, but is much less common than canned succotash or canned corn alone. Small immature ears of unripe corn are sometimes used in mixed pickles, particularly in Europe, and relishes are also made in the United States from green corn, both as a domestic article and commercially. The amount of green corn used for such purposes, however, is very small compared with that used fresh or canned.

Table 7, which follows, shows the composition of green corn, fresh and canned, succotash, and corn and tomatoes, and also includes for purposes of comparison similar data for some other common vegetables.

TABLE 7.—*Average composition of green corn and other vegetables.*

Kind of material.	Refuse.	Water.	Protein.	Fat.	Total carbohydrates.		Ash.	Fuel value per pound.
					Starch, sugar, etc.	Crude fiber.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Green corn on cob, as purchased	61.0	29.4	1.2	0.4	7.7		0.3	180
Green corn on cob, edible portion		75.4	3.1	1.1	19.2	0.5	.7	470
Green corn, canned		76.1	2.8	1.2	18.2	.8	.9	455
Green corn and tomatoes, canned		87.6	1.6	.4	9.1	.5	.8	225
Succotash, canned		75.9	3.6	1.0	17.7	.9	.9	455
Beans, Lima, fresh, as purchased	55.0	30.8	3.2	.3	9.1	.8	.8	255
Beans, Lima, fresh, edible portion		68.5	7.1	.7	20.3	1.7	1.7	570
Potatoes, as purchased	20.0	62.6	1.8	.1	14.7		.8	310
Potatoes, edible portion		78.3	2.2	.1	18.0	.4	1.0	385
Tomatoes, fresh		94.3	.9	.4	3.3	.6	.5	105

Young corn contains on an average a little more protein and starch and a little less sugar and cellulose than the mature grain, but differs chiefly from the dry ripe corn in containing much larger percentages of water. It furnishes about as much food material, pound for pound, as potatoes, but its nutritive value, as with all fresh vegetables, is low compared with that of such foods as dry ripe beans or the cereal grains. When purchased on the ear it includes over 60 per cent inedible portion or refuse, whereas the amount lost with the skin of potatoes is usually only 20 per cent. Considering the comparatively high price of green corn of good quality in the markets of large towns and cities, it is certainly a more expensive food than potatoes or some other vegetables. If grown in the home garden, however, such comparisons do not hold, and under any usual circumstances it is a reasonably economical vegetable when in season. Like most green vegetables it is more valued for its palatability and for the pleasant variety which it gives to the diet than for the nutrients which it supplies, and is certainly not expensive as compared with other foods of this class.

It is often stated that green corn is very indigestible. If the ears are not fresh and of good quality the corn may cause digestive disturbances, particularly if improperly cooked; and, as is the case with almost any other food, overindulgence may be followed by unpleasant consequences. When eaten from the cob green corn is often not thoroughly masticated and the kernels or the skin which covers them often pass through the body apparently unchanged. While of course this lessens the amount of nutritive material which the body obtains from the corn, there is no reason to suppose that this is harmful for a healthy person; but if desired the condition may be very largely avoided by running a knife lengthwise along the rows and splitting the skins of the kernels before they are eaten.

A digestion experiment made at Wesleyan University, Middletown, Conn., by Bryant and Milner, in connection with the nutrition investigations of the Office of Experiment Stations, showed that green corn when eaten in considerable quantity as a part of a simple mixed diet was fairly well assimilated, about 84 per cent of the protein and 97 per cent of the carbohydrates which it supplied being retained by the body, and on the whole it compared favorably with other vegetables which were studied at the same time. Such data are too limited for general deductions, but taken in connection with the almost universal experience that green corn when well cooked is a wholesome vegetable, they indicate that it does not deserve the reputation for "indigestibility" sometimes ascribed to it.

Succotash and corn and tomatoes are similar in composition to the vegetables of which they are composed, while canned corn has practically the same composition as the freshly cooked product.

Green corn, both fresh and canned, is often used for making soups, fritters, and other dishes, and in this way adds to the palatability and variety of the diet.

SUMMARY.

Although a native of the new world and first extensively cultivated there, Indian corn or maize is now grown very generally wherever the climate permits. In the United States corn is by far the most important cereal, and is grown in every State, though the southeastern and middle western sections are the great corn regions. The greater part of the corn crop is used for feeding live stock and poultry, or for starch making or other manufacturing purposes. Nevertheless, corn has always been and still is a favorite and very important source of human food in America, and especially in the South Atlantic States, where it ranks with wheat as a breadstuff.

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The germ of corn makes up an unusually large percentage of the kernel as compared with most grains, and as the germ is very rich in fat the grain as a whole is characterized by an unusually large proportion of this constituent. The proportion of protein is also fairly high. Carbohydrates, particularly starch, make up the greater part of the nutritive material of corn, as of other cereals. Until about fifty years ago corn was simply ground and then bolted or sifted at the mill or at home in making meal for cookery, but now it is usually kiln-dried and deprived of the outer skin and germ before grinding. The modern granulated corn meal is bolted to free it from offal products and is finer and keeps better than the old-fashioned sort, though it does not differ from it very materially in composition except that it contains a little less fat and crude fiber. The removal of the corn oil modifies the flavor, though it undoubtedly improves the keeping qualities. In general, corn meal contains a little more fat and starch and a little less protein than wheat flour, but after all it resembles this staple foodstuff quite closely in chemical composition.

The changes brought about in corn by the heat of cooking are much the same as those observed in other cereal grains. Thus, the cell walls made up of indigestible crude fiber are softened and broken down and so the starch inside may be more readily reached by the digestive juices. Heat, with or without the presence of water, changes some of the insoluble starch into forms which are easily dissolved, a condition favorable for digestion. Cooking has further advantages in that it improves the flavor of corn and thoroughly sterilizes it, a matter which may be very important under some conditions.

Corn protein does not contain the elastic, tenacious gluten which is characteristic of wheat protein and so corn meal does not give a light porous loaf with yeast. For this reason corn meal alone is seldom used for raised bread, but is usually baked in thin cakes which are granular rather than porous, although such leavening materials as eggs, sour milk with soda, etc., may be used in making the batter. When corn meal is mixed with wheat flour or rye flour the dough may be raised with yeast. Such bread, of which "rye and Indian bread is a typical example, is most palatable when slowly cooked in rather large loaves. Corn meal is often used for making mush or porridge. Under the name "hasty pudding," this dish used to be a favorite in New England and is still frequently served as a supper dish.

Samp and hominy, which are much less finely ground than corn meal, are cooked like other grits and are commonly used as a breakfast cereal or as a vegetable to accompany meat. Hominy is now frequently made without the skin and germ. Like other similar cereal goods hominy and samp require long-continued and thorough cooking, especially when coarse.

Hulled corn is an old-fashioned dish in which the kernels, instead of being ground or degerminated, are steeped in lye until the hulls are loosened, soaked in clear water until free from alkali, and then boiled until soft and tender.

There are various proprietary breakfast foods made from corn. In most of these the grain has been cooked until tender and then rolled or flaked and sometimes parched with or without the addition of malt or other flavoring material.

Small hard varieties of corn when shaken over a hot fire pop or burst to a white, light mass, owing to the sudden expansion to steam of moisture in the cells making up the interior of the grain. Popped corn is sometimes used at table, but is usually eaten out of hand. The total amount consumed is fairly large. Varieties of corn which will not pop are sometimes parched and eaten and are also used as a coffee substitute.

Cornstarch has long been an important foodstuff commonly used for making puddings and desserts and for invalid cookery. Glucose made from cornstarch is a very common commercial product. The use of corn oil as a culinary fat is comparatively recent but seems promising.

Corn meal and other corn products are used in making an endless variety of batter breads, cakes, and other dishes for which recipes may be found in books devoted to cookery.

Unripe or green corn is frequently used as a vegetable, particularly in America. Like all green vegetables it is succulent and contains a small amount of nutritive material in proportion to its bulk, being esteemed for its pleasing flavor and the variety which it gives to the diet rather than for its direct food value. Corn canned alone or mixed with beans or tomatoes is a common commercial product, reasonable in price, and a useful addition to the list of vegetables, particularly in the winter diet.

Careful experiments made to test the digestibility of corn indicate that the carbohydrates are almost completely utilized by the body no matter how the grain is cooked. The method of preparation, however, apparently makes considerable difference in the digestibility of the protein. Thin, porous corn bread, such as johnnycake, and even the thick loaves of Boston brown bread, made of equal parts of corn, rye, and wheat, furnish as large a proportion of digestible protein as white wheat bread raised with yeast. On the other hand, he protein of hoecake (corn meal mixed with water and baked in hin sheets) has been found to be slightly less digestible than that of wheat bread, while the protein of hasty pudding and boiled hominy is only about 73 per cent digestible as compared with 83 to 86 per ent in the above-mentioned types of corn bread.

The corn breakfast foods and other corn products have much the ame digestibility as corn meal when cooked in similar ways. The variations which have been noted with the different corn breads and other corn dishes are of the same character as those observed with similar foods made from wheat flour of different sorts.

Corn, though a wholesome and very useful foodstuff which may be cooked in many ways, is not likely to replace wheat as a leading breadstuff where the latter can be obtained, as wheat bread is commonly considered to be more appetizing for everyday use and has an advantage in that it keeps for a longer time in good condition after baking. Corn breads, however, give a pleasant variety to the diet, and being more easily and quickly made than wheat bread are especially useful when hot bread is wanted and time is limited. Corn breads and corn cakes are so easily made that they are favorites in camps and wherever cooking appliances are few and simple.

Where conditions are especially favorable to corn cultivation, as in the mountain districts of the southeastern United States, some parts of Italy, and the Balkan regions of Europe, corn is often the staple cereal food and not infrequently the principal article of diet for the poor. In times of distress people have lived on this grain alone for considerable periods, but, like other grains, it contains too little protein in proportion to its fat and carbohydrates to supply the body with nutritive material in the proper proportion, and it should be combined with materials rich in protein, such as lean meat, milk, cheese, dry beans, etc. When thus combined it is a healthy, nutritious, and inexpensive food and has been proved by common experience to be wholesome, palatable, and a welcome addition to the diet.

Considering all of its uses, corn is one of the most important cerea foods from the standpoint of palatability, nutritive value, an digestibility. It may be prepared for the table in a great variety ways, and in some form or other is deservedly used in the majority American homes.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 299.

DIVERSIFIED FARMING UNDER THE PLANTATION SYSTEM.

BY

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AND

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1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 8, 1907.

Sir: I have the honor to transmit herewith a paper entitled "Diversified Farming under the Plantation System" and to recommend that it be published as a Farmers' Bulletin.

This paper was prepared, under the direction of the Agriculturist in Charge of the Farm Management Investigations of this Bureau, by Mr. D. A. Brodie and Mr. C. K. McClelland, who have conducted careful investigations on this subject for several years past.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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DIVERSIFIED FARMING UNDER THE PLANTATION SYSTEM.

INTRODUCTION.

At sundry times and at various places much of the farm land of this country has been devoted to the growing of one particular crop. If for a series of years a certain crop brings a high price, many farmers are likely to plant large areas of that crop, and often the entire farm is given over to it. Again, certain soils in certain climates lend themselves peculiarly to the best development of a certain crop, and here also the entire acreage is likely to be in that particular crop.

Without disputing the good points of such practice, such as the profits secured at times, the possibility of establishing a reputation for a certain product, the thorough knowledge obtained of a particular crop and its peculiarities, and the small equipment of machinery required for it, it is only necessary to point out some of the evil results of the system in order to convince most people of its harmfulness.

One result of the continued cultivation of a single crop is the infection of the soil with spores of fungous diseases peculiar to the plant grown. The practice also results in a rapid depletion of soil fertility. In unfavorable years—years of frost, of drought, of much rain, of insect attacks, or of very low prices—the farmers who depend upon one crop are brought to a realization of the value and the necessity of diversification.

In the United States there have been many examples of this lack of diversification, and also many examples of the resulting evils. In the Central States corn was grown for many years on the same soil until low prices and low yields compelled the farmers to diversify. In he North and the Northwest wheat was, and in many places is still, almost the only crop grown. Many farmers who depended upon it alone went out of business during several successive unfavorable periods. Similar results have been observed at various times with otton, sugar cane, rice, potatoes, hops, grapes, peaches, apples, nions, and other crops. Just recently a disease has been found pon melons which may make it more profitable to grow some other crop for a few years. There is also a root-rot appearing upon radishes which may necessitate the abandonment of that crop upon infected soils. So, also, the ravages of the boll weevil are compelling the southern farmer to diversify. If the boll weevil causes both the upland and the bottom-land farmers of the South to diversify and rotate their crops, it will prove to be not an unmixed evil.

Upland farmers take more readily to diversification and rotation than do the river-bottom planters, and for several reasons. In the first place their soils are poorer, and a rotation of crops is imperative in order to obtain any reasonable yield, while the bottom soils have such a mine of fertility in and beneath them that it is often many years before there is any noticeable decrease in yield, even where only one crop is grown. The average number of acres to the owner is less on the hill than on the bottom land and the tenants are fewer in number. The hill farmers usually live upon their farms, while the bottom-land planters as a rule reside in town, where it is impossible for them to keep an eye upon all the details of a diversified system of farming. Besides being in a position to better oversee the work, the hill farmers also do more of their own work, and this is an important factor in diversification. It can hardly be expected that a class of tenants whose crop of cotton often grows in spite of, rather than because of, them will make a success of live stock, truck, or fruit growing—complex industries which require a more thorough knowledge of scientific agriculture. After tenants have been instructed how to handle such products and have become accustomed to them there will be less difficulty in planning for diversification. The bottom-land planters usually keep only enough live stock to carry on the work of the plantation, while it is no uncommon thing to find a hill farm with twenty to thirty head of cattle, an equal number of swine, and several head of mule or horse colts. The keeping of live stock necessitates growing more forage crops; consequently more of the total acreage of the farm must be devoted to the raising of this feed. These forage crops are fed to the live stock and the manure is returned to the soil, thus preserving its fertility.

The planters maintain that because of the roving tendency of the tenant class they can not plan for diversified farming. This roving is partly due to the desire of the tenant to better himself, each man wanting to work where he can make the most money. In the two examples cited later the planters say that to hold their tenants all they have to do is to show that the tenants can make more on that particular plantation than upon any other. The planters do this by encouraging their men to fix up their homes, so that they will be homes in the true sense of the word, to grow as much as possible upon their holdings of what they need to eat, to keep more or less live stock, and to raise forage for that stock. And then the planters advise them to grow such crops as will bring in money at various seasons of the year. It is no trouble to hold a tenant with such surroundings and with another pay day only a few weeks ahead, but it is very easy to lose one when there is only an annual pay day, as is the case when cotton is the only money crop.

One of the main reasons for this lack of diversification is the lack of forehandedness among the tenant class and the disinclination of the planters and the merchants to lend money or supplies on anything but cotton. This is because cotton is "tangible." A dishonest tenant can dispose of eggs, butter, grain, pork, hay, or truck without the knowledge of his creditor, but a cotton bale is too large to escape undetected, and especially so as the planter gets a record of it as it passes through the gin. Unfortunately, it is true that most of the merchants do not want to abolish the credit system. It is to their advantage to continue it, and some of them fail to see that the entire country is held back because of it.

Many of the planters affirm that there is no money in anything but cotton, but this has been proved a fallacy. At the present prices of pork and the cheapness of producing it in the South, and at the present prices of hay and other forage, of cowpeas for seed, of good cows, of truck, and of mules, money can be made in diversified farming.

The planters are held in a system fixed by their predecessors. This system was a development through a series of years of very peculiar conditions, a development in which few of the present planters played a part, but resulting in a system from which many of them do not care to depart and do not know how to depart. This paper is intended to show those who may desire to change their methods how other men have started in the work of diversification.

Mr. F. M. Greene, of Atlanta, Tex., instructs each of his tenants to devote a few acres each year to Irish potatoes, and then, by digging all at the same time, a carload is obtained for shipment. Later in the summer cabbages are planted on this land, to come off in January and February. This last winter (1906–7) a profit of $150 an acre was realized on the cabbage crop. This is a simple system of diversification, but it gives the men three money crops at three different times of the year.

AN EXPERIMENT IN DIVERSIFIED FARMING.

In 1906 the Louisiana Agricultural Experiment Station and the United States Department of Agriculture began some diversification work with the tenants on the Rosalie Plantation at Moreland, La., owned by Mr. William Polk, of Alexandria, La. Mr. Henry Easterbrook, of Pineville, La., had direct charge of this work, under the supervision of the Office of Farm Management Investigations of the Bureau of Plant Industry.

Each tenant set aside for this experiment nearly 2 acres of land, on which he planted potatoes, watermelons, sweet corn, and cabbage—approximately one-half acre of each. These crops were planted at the same time by all of the tenants, so as to be ready for harvest at the same time upon all of the fields.

Because of poor seed and excessive rainfall in the early spring the corn crop was very poor. In four instances it was a complete failure, while in the others there was an insufficient quantity for marketing, and it was therefore fed to stock upon the place. From May 6 until June 26, 1906, there was no rain, and because of this the cabbage crop was also a failure. One tenant, A. Palmer, planted sweet potatoes when the corn and cabbage failed. These yielded at the rate of 271 bushels to the acre. Half of the crop was sold at prices ranging from 50 cents to a dollar per bushel, the average price being 60 cents. The other half was kept for family use.

The Irish potato crop was decidedly a success, as shown by Table 1, only one tenant reporting a failure:

Table 1.—*Potato crop, 1906, of tenants on the plantation of William Polk, near Morland, La.*

Serial No.	Name of tenant.	Area planted.	Yield of the plot.	Yield to the acre.	Gross receipts.	Expenses to the acre.					Net profit.	Loss.	Net profit to the acre
						Fertilizers.	Seed.	Bags.	Rent.	Total.			
		Acres	*Bush.*	*Bush.*									
1	H. Edwards	2/7	31	107 5/7	$27.90	$6.88	$6.88	$1.26	$0.73	$17.75	$12.15	......	$42.
2	N. Dixon	⅜	40	106⅔	36.00	3.44	6.88	1.68	.94	12.94	23.06	......	61.
3	J. Crawford	⅓	34½	103½	31.13	3.44	6.88	1.40	.84	12.56	18.57	......	55.
4	J. Brown	½	47 7/10	95⅖	42.93	3.44	6.88	1.75	1.25	13.32	29.61	......	[illegible]
5	G. Mason	½	43¼	86½	38.85	3.44	6.88	1.75	1.25	13.32	25.53	......	51.
6	J. Chase	½	41 1/8	82¼	37.14	3.44	6.88	1.68	1.25	13.25	23.89	......	[illegible]
7	T. Grimble	½	36⅛	72¼	32.55	3.44	6.88	1.40	1.25	12.97	19.58	......	[illegible]
8	A. Figgins	4/9	31 7/12	71 1/16	28.43	3.44	6.88	1.33	.94	12.59	15.84	......	[illegible]
9	W. Odom	½	34⅝	69¼	31.35	3.44	6.88	1.47	1.25	13.04	18.31	......	[illegible]
10	I. Carey	½	31½	63	28.35	3.44	6.88	1.33	1.25	12.90	15.45	......	31.
11	T. Jefferson	9/20	30⅝	68	27.83	4.13	6.88	1.19	1.13	13.33	14.50	......	[illegible]
12	H. Thompson	½	28 7/12	57⅙	25.73	3.44	6.88	1.26	1.25	12.83	12.90	......	25.
13	A. Williams	½	28¼	56½	25.43	4.13	6.88	1.33	1.25	13.59	11.84	......	[illegible]
14	S. Goodman	½	26⅝	53¼	24.00	3.44	6.88	1.12	1.25	12.69	11.31	......	[illegible]
15	S. Money	½	25 5/12	50⅚	23.03	3.44	6.88	1.05	1.25	12.62	10.41	......	20.
16	P. Thompson	½	21⅝	43¼	19.58	3.44	6.88	.91	1.25	12.48	7.10	......	14.
17	A. Palmer	½	19⅝	39¼	17.70	3.44	6.88	.84	1.25	12.41	5.29	......	10.
18	E. Brown	½	3 11/12	7 10/12	3.53	3.44	6.88	.14	1.25	11.71	......	$8.18	
	Total	8⅓	556 13/60	1,234 7/12	501.46	66.74	123.84	22.89	20.83	234.30	275.34	8.18	
	Average, including No. 18	......	......	61.⅜	......	......	......	......	......	28.20	......	......	32.
	Average, excluding No. 18	......	......	70.½	......	......	......	......	......	......	......	......	[illegible]

It will be seen that the net profits to the acre on the crop of Irish potatoes varied from $10.58 to $61.49, averaging $32.10, including the one failure. The yields varied from nearly 8 to 107 bushels to the acre, averaging 61⅞ bushels. If, however, the one failure is not taken into consideration, an average yield of 70¼ bushels and an average profit of $35.20 to the acre are shown. These potatoes were dug on May 21 and 22, 1906, and sold in the car at 90 cents a bushel. The yields would have been larger but the price lower had they been dug one week later. In addition to this crop of potatoes with profits of over $30 per acre, it would have been possible to have grown afterwards a good crop of Mexican June corn, or cowpeas, or other crops upon this same land and to have followed these by some winter crop.

When it is considered that none of these tenants had ever before grown Irish potatoes and had to be instructed in their cultivation from the very beginning, the possibilities open to them in the future as they become more familiar with the crop can be seen.

The watermelons were sold in Alexandria and other neighboring towns as they matured, bringing an average of 7 cents each. Watermelons grown upon bottom lands are poorer in quality than those produced upon the hill lands, and bring less upon the market. One load of these melons was sold on the State camp grounds, but the demand for them was slight because of their poor quality. It will be seen from Table 2 that the yields varied from 0 to 600 melons to the acre, averaging about 300 per acre for the 15 productive plots recorded. The results in money varied from a loss of $4.54 on half an acre to a gain at the rate of $85.83 to the acre, the average profit being $25.41.

TABLE 2.—*Watermelon crop, 1906, of tenants on the plantation of William Polk, near Moreland, La.*

Name of tenant.	Number grown to the acre.	Area.	Expenses to the acre.				Gross receipts.	Net profit.	Loss.	Net profit to the acre.
			Fertilizer.	Seed.	Rent.	Total.				
		Acres.								
. Grimble	600	8/13	$2.06	$1.02	$1.80	$4.88	$57.70	$52.82	....	$85.83
. Thompson	600	½	2.06	1.02	1.46	4.54	39.00	34.46	....	68.92
V. Odom	450	9/13	2.06	1.02	2.03	5.11	34.50	29.39	....	42.45
. Goodman	400	6/13	2.06	1.22	1.35	4.63	23.85	19.22	....	41.64
Carey	410	11/26	2.06	1.02	1.24	4.32	17.50	13.18	....	31.15
. Mason	300	9/13	2.06	1.02	2.03	5.11	25.00	19.89	....	28.73
. Dixon	280	½	2.06	1.02	1.46	4.54	18.50	13.96	....	27.92
. Figgins	260	½	2.06	1.02	1.46	4.54	17.50	12.96	....	25.92
Chase	240	½	2.06	1.02	1.46	4.54	16.50	11.96	....	23.92
Money	220	½	2.06	1.02	1.46	4.54	15.40	10.86	....	21.72
Crawford	214	11/18	2.06	1.02	1.79	4.87	18.00	13.13	....	21.48
. Williams	200	½	2.06	1.02	1.46	4.54	14.75	10.21	....	20.42
Brown	225	½	2.06	1.02	1.46	4.54	10.60	6.06	....	12.12
. Edwards	103	½	1.04	1.02	1.17	3.23	6.30	3.07	....	7.68
. Thompson	(a)	7/11	2.06	1.02	1.91	4.99	8.40	3.41	....	5.21
Jefferson	27	½	2.06	.81	.59	3.46	4.00	.54	....	2.70
Palmer	0	½	2.06	1.02	1.46	4.54	....	....	$4.54	....
Brown	0	½	2.06	1.02	1.46	4.54	....	....	4.54	....
Total	4,529	9½	36.06	18.35	27.05	81.46	327.50	255.12	9.08	467.81
Average for the 15 plots recorded	300	....	....	....	....	....	....	....	....	25.41

[a] No record.

The figures in Tables 1 and 2 include the rent of the land and the cost of seed, fertilizers, and bagging for the potatoes, but do not include any expense for labor. The rent is figured at $5 an acre for the time actually taken to produce the crop.

From observations during the first year's work it was clearly seen that it was possible to establish a system of diversification on plantations and that the tenants were eager to raise other things than cotton, provided the owner was willing and they had some little instruction in the care of the new crops. However, it was noticed that true diversification is possible only where the tenant lives upon the land which he tills. When this is the case he can keep live stock, raise the necessary feed, provide pastures, and attend to the little details required by a diversified farm. Where a tenant lived a few miles from his holdings he lost too much time in going back and forth and was unable to give the necessary attention to his crops.[a] Because of this loss of time the owner during the past winter has moved many of his cottages from the old "quarters" to the holdings of the tenants. Many of the houses have been remodeled. A prize is offered to the tenant showing the most taste in the improvement of his home and environments.

All the tenants were much pleased with the experiment and desired to continue it. The owner is now one of the greatest diversification enthusiasts in the South. For 1907 he has planned to diversify further by adding sugar cane, alfalfa, and other crops to his list. (See Table 3.) He also has extended the work to his adjoining plantation.

Table 3 gives the names of the tenants on Emfield and Rosalie plantations, with the acreages which they have in each crop. The larger acreage is still in cotton and corn, but there are considerable areas in ribbon cane, alfalfa, and Irish potatoes, each tenant having from 1 to 5 acres of each of these crops. Then there are smaller areas in watermelons, cabbages, and sweet potatoes.

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[a] The cabbage crop referred to might have been saved had the tenants lived near enough so as to have been able to water it.

TABLE 3.—*Kinds of crops, with acreages, grown by tenants of William Polk in 1907, with number of live stock kept.*

Name of tenant and number in his family.	Cotton.	Cane.	Potatoes.	Corn and peas.	Alfalfa.	Melons.	Sorghum.	Cabbage.	Sweet potatoes.	Miscellaneous garden vegetables.	Mules.	Horses.	Cattle.	Hogs.
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*No.*	*No.*	*No.*	*No.*
A. Figgins (2)	22	¾	2	23	2	1	¼	......	½	¼	2	1	3	10
T. Jefferson (4)	10	2	2	8	2	¾	¼	......	½	¼	3	1	3	9
A. Palmer (8)	26	1½	3	8	1½	1	¼	½	½	¼	1	2	....	3
I. Jackson (2)	13	½	2	7	3	1	¼	......	½	¼	1	....	....	1
A. Straceneer (5)	16	3	3	15	......	¾	¼	¼	1	1	2	1	5	5
A. Williams (6)	30	½	5	16	2	1	¼	¼	1	¼	3	1	3	8
I. Carey (8)	25	3½	4	14	2½	½	¼	¼	½	1	3	1	2	7
G. Mason (10)	20	5	5	13	2	1	¼	¼	1	¼	2	1	4	15
P. Thompson (4)	20	6	4	12	2½	1	1	1½	1	¼	2	4	6	4
W. Odom (10)	48	1	12	38	6½	1	¼	1	2	1	7	2	14	20
T. Grimble (7)	17	1½	2	9½	2	1	......	½	½	¼	1	1	8	10
W. Thompson (3)	15	3	3	8	1	½	¼	......	½	¼	1	2	4	5
J. Chase (4)	18	1½	3½	7	1½	1	¼	1	½	¼	2	2	....	6
H. Edwards (8)	28	2	3½	15	1½	1	¼	1½	1	1	3	1	5	8
E. Johnson (5)	14	½	2	10	1½	2	¼	¼	½	¼	2	1	1	3
W. King (10)	17	½	2	9	2	½	¼	½	½	¼	2	1	2	3
H. Griffin (6)	15	3	4	10	2	1	¼	¼	½	¼	2	1	2	10
L. Foster (9)	20	1	4	12	2	1	¼	½	½	¼	2	1	....	6
W. Boxter (5)	19	½	2	9	1	1	¼	¼	½	¼	....	3	....	1
B. Purdy (6)	15	½	2	8	1½	1	......	......	½	¼	1	1	2	7
R. Bayou (3)	13	1	2	6	1	1	¼	......	½	¼	2	1	....	1
M. Weldon (2)	12	⅛	2	10	......	1	¼	1	1	1	1	1	2	3
A. Ashley (4)	12	......	3	6	......	½	¼	½	½	¼	2	....	3	5
M. Odom (2)	12	......	2	8	......	½	¼	......	½	¼	1	1	4	2
J. Colletto (3)	40	......	20	10	......	1	......	2	......	¼	2	2	1	....
M. Gercinto (6)	17	......	2½	2½	......	1	¼	3	1½	4	2	....	....	2
D. Romero (5)	26	......	3	5	......	½	¼	......	½	1	2	....	....	2
S. Goodman (4)	30	5	......	20	......	1	1	¼	½	¼	4	1	6	2
B. Barnado (5)	18	3	3	12	½	1	¼	¼	½	¼	2	....	....	1
J. Williams (2)	15	1½	2½	7	......	½	¼	½	½	¼	1	1	2	1
S. Monie (4)	25	1	3	15	1	1	¼	......	1	¼	2	2	3	7
J. Brown (5)	27	5	1	11	3	1	¼	½	½	¼	2	1	1	16
E. Brown (9)	23	......	4	6	......	1	¼	½	1	¼	2	....	....	2
N. Dixon (12)	40	6	5	15	2	1	¼	½	2	¼	2	4	5	26
J. Crawford (6)	22	5	2	14	2	1	¼	½	1	¼	3	2	1	4
H. Burrel (3)	25	1	4	15	3	1	¼	1	½	¼	4	....	2	1
H. Low (2)	12	......	......	3	......	......	......	......	½	¼	....	....	....	2
Total	777	66⅜	129	417	52½	32¾	10⅞	19¼	27⅛	18⅜	76	44	94	213

In addition to the crops specified, three tenants had an eighth of an acre each in onions; two, one-fourth acre each in peanuts; one, one-fourth acre in sweet corn; and one, 6 acres in Johnson grass, while one tenant had three-fourths of an acre each in clover and in oats and vetch, one-half an acre each in radishes and rape, and an eighth of an acre each in tomatoes, beans, okra, and cantaloupes.

The income will be derived from Irish potatoes, watermelons, cotton, and ribbon cane, in the order given, while many of the tenants will also have small quantities of sweet potatoes, cabbages, and other truck to sell, and perhaps a little pork. In addition to this, these tenants have had their own milk, butter, eggs, and vegetables; they have raised their own poultry, pork, and hay, and at the end of the year will be much better off than when they paid out for these things all they received for the cotton crop.

CONCLUSION.

The tenant's prosperity is identical with that of the planter. It is therefore to the advantage of the planter to encourage diversified farming among his tenants. It is hoped that many planters will learn from the description of these experiments in Louisiana not only the benefits of diversification but also how to start the work. Not every one will be so situated as to follow this outline exactly, but the principle is plain and some plan can be evolved which will work equally well under other conditions.

FARMERS' BULLETINS.

The following is a list, by number, of the Farmers' Bulletins available for distribution. The bulletins entitled "Experiment Station Work" give in brief the results of experiments performed by the State experiment stations. Titles of other bulletins are self-explanatory. Bulletins in this list will be sent free to any address in the United States on application to a Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C. Numbers omitted have been discontinued, being superseded by later bulletins.

22. The Feeding of Farm Animals. Pp. 40.
24. Hog Cholera and Swine Plague. Pp. 16.
25. Peanuts: Culture and Uses. Pp. 24.
27. Flax for Seed and Fiber. Pp. 16.
28. Weeds: And How to Kill Them. Pp. 30.
29. Souring and Other Changes in Milk. Pp. 22.
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33. Peach Growing for Market. Pp. 24.
34. Meats: Composition and Cooking. Pp. 31.
35. Potato Culture. Pp. 24.
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61. Asparagus Culture. Pp. 40.
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79. Experiment Station Work—VI. Pp. 27.
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82. The Culture of Tobacco. Pp. 22.
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86. Thirty Poisonous Plants. Pp. 32.
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88. Alkali Lands. Pp. 23.
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FARMERS' BULLETIN 300.

SOME IMPORTANT GRASSES AND FORAGE PLANTS FOR THE GULF COAST REGION.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 18, 1907.

Sir: I have the honor to transmit herewith a paper entitled "Some Important Grasses and Forage Plants for the Gulf Coast Region," and recommend that it be published as a Farmers' Bulletin. This paper was prepared by Prof. S. M. Tracy, under the direction of the Agriculturist in charge of the Farm Management Investigations of this Bureau. Professor Tracy has given careful study for several years past to the subjects discussed in these pages.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—291.

SOME IMPORTANT GRASSES AND FORAGE PLANTS FOR THE GULF COAST REGION.

MEXICAN CLOVER.

Mexican clover (*Richardsonia scabra*) (fig. 1), sometimes called "pusley" or "purslane," though entirely different from the plant known by those names in the North, is not a true clover, but belongs to the same family as the madder, poverty weed, and a number of other common plants. It is an annual which grows about as large and which has much the same habit of growth as the common red clover, but its leaves are opposite and simple instead of being alternate and 3-parted, as in the true clovers. It grows most abundantly in sandy cultivated fields from which early crops have been removed, and often makes a heavy growth in corn and cotton fields after those crops have been laid by. It is seldom planted, as, like crab-grass and beggarweed, with which it is usually found, it makes a volunteer growth late in the season and the yield would be increased very little if it were sown early and the ground given up to it through the entire year. It is common in old fields, from southern Florida to central Georgia and westward to southern Mississippi, making a fair growth on soils too poor and sandy for most other crops and being more thrifty on fertile fields, where it often makes a growth of 4 to 5 feet.

Mexican clover is used both for hay and for grazing. While the ay is somewhat hard to cure when cut early and is not of the best uality, it is eaten readily by most animals. It is usually more or less nixed with crab-grass and beggarweed, and adds largely to the bulk nd value of a volunteer crop of these. When used for grazing, Mexcan clover is more valuable for hogs than for other stock. It can be razed from about May until after heavy frosts, and will then reseed he ground abundantly. The seeds are very small and difficult to ave, though they are sometimes beaten out with flails or gathered rom the bottom of a mow in which the hay has been stored. For eding, 4 or 5 pounds per acre is sufficient, but the more common ethod of distributing the plant is by mowing after the seed is mared, and then scattering the hay over the field on which the crop is anted the following year.

Opinions as to the value of Mexican clover differ widely, some farmers regarding it as a worthless weed, while others praise it very highly. One grower in northern Florida, who has cultivated it for fifteen years, reports that during last summer he kept 4 horses and 20 hogs for eight months on a field of 7 acres. This field had been in oats the previous season, and the growth, though somewhat mixed with crab-grass and beggarweed, was mostly Mexican clover. Another grower in extreme western Florida, who has grown this forage plant quite largely for twelve years, declares that it is a valuable volunteer plant in his cultivated fields, as it makes a heavy growth on ground which would otherwise be vacant and adds largely to the yie of lands growing cowpeas, crab-grass, and other fall hay crops. C tle and mules eat it readily, while hogs graze it with relish. Whe not required for forage, it gives a needed protection to the soil dur winter, and is so thoroughly decayed by spring that it is not in way of the plow. A liveryman at Thomasville, Ga., where the pla is quite common, says that it is as nearly worthless as anything e made into hay, and that he will not use hay with which it is mix A southern Mississippi grower, on the contrary, says: "Cattle pick it out from any other hay and eat it in preference to any." Si lar conflicting statements could be quoted from nearly every sect in the region in which it is grown.

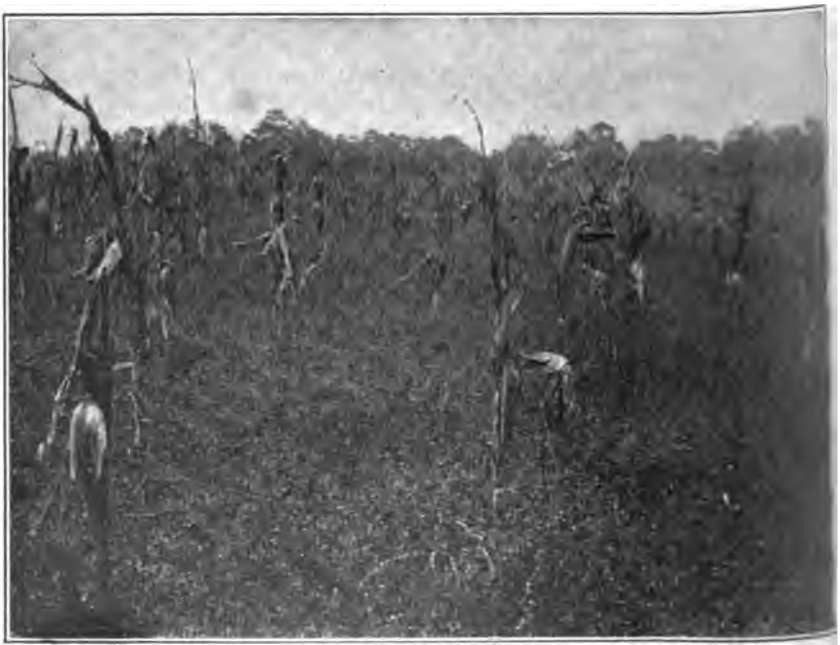

FIG. 1.—Mexican clover in corn, Monticello, Fla.

While Mexican clover is not a nitrogen-gathering plant, like the true clovers, its growth is usually volunteer and so costs nothing; it protects the surface of the ground from the scorching sun in summer and from washing rains in winter, and adds to the fertility of the soil by providing humus. The plant should be regarded as an inexpensive substitute for something better rather than as one to be generally cultivated at much expense.

BEGGARWEED.

Beggarweed (*Desmodium tortuosum*) is an important forage plant from southern Florida northward to southern Georgia and Alabama, though it is seldom found west of the Alabama River. It is an annual legume which is common as a volunteer growth in old fields with sandy soils, making its best growth late in the season—at the same time that crab-grass is growing most rapidly. It is erect in habit, reaching a height of 5 to 7 feet on good soils, and is used for hay, silage, and grazing. Like crab-grass, with which it usually grows, it makes a scattering and uneven volunteer growth on land which has not been plowed during the year, though, when occasional strips are left standing at the second cutting and the field is afterwards harrowed crosswise to scatter the seed, a good crop is often secured the second season after plowing. The volunteer growth, however, as is the case with all volunteer crops, is uneven and somewhat uncertain, and the better practice is to reseed the ground after oats, melons, or other early crops have been removed, using 25 to 30 pounds of rough seed to the acre. The seed is usually saved by stripping it from the plants by hand, the labor making the seed cost about 3 cents a pound.

In regions where beggarweed is grown most commonly it is seldom found as a volunteer crop on newly cleared lands, but it is more or less abundant in nearly all old fields, especially in cornfields (fig. 2) and cotton fields, where it springs up after the crop is laid by and where it furnishes a large amount of fine grazing after these crops have been gathered. Some cotton growers object to beggarweed in their fields, as the immature seeds are somewhat rough and, when switched about by the wind, often pull the seed cotton from the bolls. It is easily killed by a single cultivation in late summer and soon disappears from fields which are not plowed.

When used for hay beggarweed should be cut about the time it is beginning to bloom, in June or July, and a second cutting can then be made a few weeks later. When cut at the right time and properly cured it has no superior for hay, but it must be handled with care and should be windrowed as soon as wilted to prevent the leaves from dropping. If allowed to become too old before it is cut, many of the lower leaves are lost and the stems become hard and woody, though if run through a shredder the stems are eaten readily by stock, even when quite mature. It makes a yield of from 1 to 2 tons per acre. The hay, especially that made from the second cutting, is usually mixed with more or less crab-grass, cockspur, and Mexican clover. When well cured the hay is very fattening; dairymen prize it highly for the flavor which it gives to milk when fed during the winter, and they often sow the seed with cowpeas for that reason.

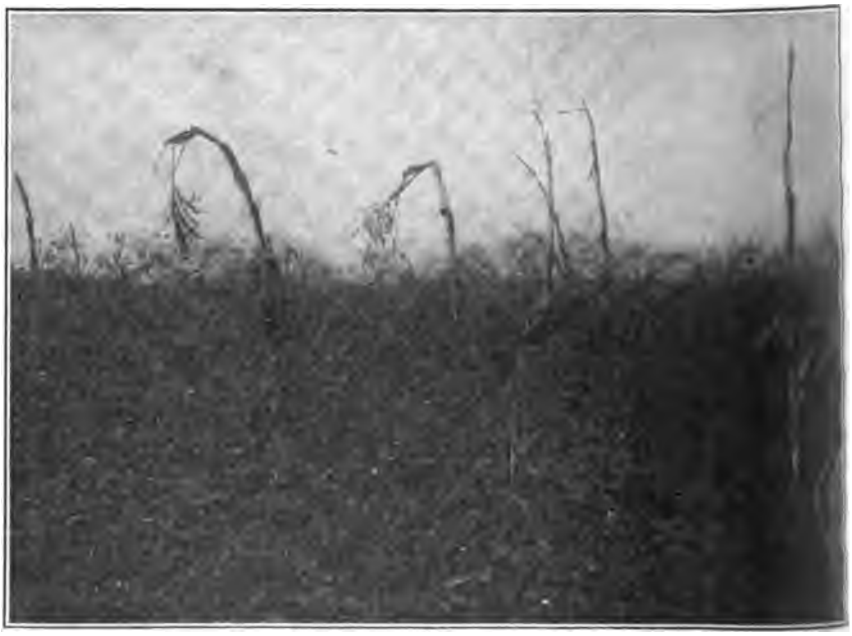

FIG. 2.—Florida beggarweed in corn, Monticello, Fla.

Although not sufficiently bulky for use alone in filling a silo, a little beggarweed adds greatly to the value of silage, as it gives a marked "June" flavor to butter, even when fed in midwinter. Its greatest value, however, is as a grazing plant for late summer and fall. All kinds of stock eat it with relish and make rapid gains in flesh while pasturing on it.

While beggarweed is a crop of secondary importance and fields are seldom used for growing it alone, it is a welcome addition to any hay crop, and when it is so abundant as to afford good grazing it will fatten horses, mules, and cattle more quickly than any other plant.

VELVET BEANS.

The velvet bean (*Mucuna utilis*) is the most rank-growing legume cultivated for forage and is one of the most valuable annual plants both for the production of feed and as a restorative crop in a rotation. It is not as good as the cowpea for making hay, as its growth is so strong and the vines are so long and tangled that it is difficult to cut and cure, but it makes an immense amount of fall and winter grazing, produces seed abundantly, and leaves the soil in a fine condition for any succeeding crop. It needs a long season (about eight months) for maturing, and so is rarely grown north of a line from Savannah, Ga., westward to Austin, Tex., and is most common on the sandy lands east of the Mississippi River. It is grown more extensively in Florida than elsewhere, there probably being more acres devoted to the crop in that State than in all the rest of the country.

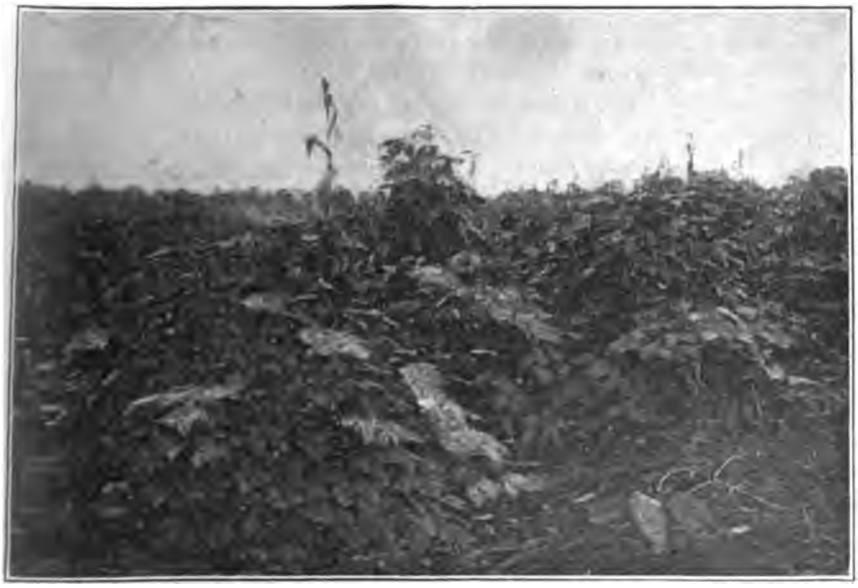

FIG. 3.—Velvet beans in corn, De Funiak Springs, Fla.

The velvet bean is one of the best plants for newly cleared lands, as its growth is so dense and rapid that it smothers all weeds, sprouts, and grass and as it "civilizes" the soil better than any other crop. The vines should be given some support to keep them up from the ground, as otherwise they will not fruit well or make the most vigorous growth. Poles are sometimes used for that purpose, but are expensive and troublesome, and cornstalks are more commonly used (fig. 3). Some strong-growing variety of corn, often the "Mexican June," is planted at the same time as the beans, or a few days earlier, and the stalks give the needed support to the vines. Some planters prefer to top the corn as soon as the ears are fairly mature, claiming that the part of the stalk which is left is not pulled over by the vines as easily as is the whole stalk; others plant three rows of corn and one of beans, claiming that in that way they get a good crop of both corn and beans; still others plant the corn in 7-foot rows and when it is about a foot high plant beans in the middles. When planted in that way the corn matures a full crop and the bean vines have a fair support. Planting is done as early in the spring as is safe, as late plantings never make seed as freely as do those made as soon as there is no further danger from late frosts. From 6 to 8 quarts of seed per acre are used. The heaviest yields of both vines and seed are undoubtedly secured when the beans are planted in every row at the same time the corn is planted, but with such treatment the yield of corn is usually small.

With a good support for the vines the yield of seed is very heavy—from 40 to 75 bushels per acre. The seed is gathered by hand at a cost of from 15 to 20 cents for a barrel of pods, which will make a little more than a bushel of shelled beans. Thrashing is rather difficult, as the pods are tough and very close together, but at present prices the seed alone makes a profitable crop. When a crop of seed has been gathered, the vines and immature seeds which are left still make rich grazing, and the fertilizing effect of the crop on the soil is little changed.

A dairyman in northern Florida reports that he had 20 acres of velvet beans last year and began grazing them just before frost. He grazed 30 cows one-half of each day for twenty-seven days, and then gathered 20,000 pounds of beans in pods. These were ground, steamed, and mixed with wheat bran and cotton-seed meal, which made a rich feed for his cows. Another grower in southern Georgia states that he grazed 100 cattle for four months on 80 acres of the beans, the cattle beginning to graze immediately after the first frost. He follows a rotation of cotton, corn followed by winter oats, and velvet beans after the oats are harvested in May. This rotation makes the beans mature too late for their best growth, but gives a good profit on the work, as the cotton this year yielded a trifle more than a bale to the acre on land where beans were grown last year, and that without any other fertilizer. He plants the beans about 1 by 3½ feet apart and cultivates twice.

A grower in western Florida last year planted a field of 6 acres of velvet beans early in April. In June he put 60 hogs in the field. These hogs ate the volunteer Mexican clover first, and then the volunteer beggarweed, doing so little harm to the beans that 12 tons of hay were cut from the field in September. The same grower states that beginning in October seventy days of grazing on velvet beans will make a steer ready for market.

Grazing usually begins at about the time of the first frost and may be continued until February or March, as both the vines and the beans remain in edible condition through the winter. The beans are quite hard when matured and dry, but are eaten well in the fall or whenever they become slightly softened by rains or by lying on the damp ground, so that all are consumed before the ground is plowed in the spring. Dairymen find that fall grazing is the greatest stimulus to milk production, while beef growers value velvet beans more highly for winter feeding. The dry beans are so hard that they do not rank high for feeding. Horses do not eat them well, as the short, stiff hairs on the pods soon give them sore mouths, while grinding and steaming are too expensive for ordinary purposes.

The plant is seldom used for hay on account of the difficulty in cutting and curing. When cut early and well cured the hay is of fine quality, but when cut late many of the leaves are lost and the stems become dry and woody. As a hay plant it is less satisfactory than the cowpea.

The principal value of the velvet bean is as a crop for winter grazing, and for that purpose it is the best plant grown in the Gulf region. It grows well on soils which are very light and sandy and produces a heavy yield of excellent feed, but it occupies the ground through the entire year and so can not take the place of the vetches, crimson clover, or cowpeas as a catch crop for a short season.

GUINEA GRASS.

Guinea grass (*Panicum maximum*) (fig. 4) is an African species which is a common grazing grass in Cuba and other West Indian islands. It was introduced into southern Florida as early as 1870 and probably much earlier. It has often been confused with Johnson grass, which has been called by the same name, though very different in appearance and habit of growth. Johnson grass spreads by long, fleshy, underground stems and has seeds which are of a yellow, red, or black color, while the true Guinea grass grows in dense, erect clumps, does not spread by underground stems, and has smaller seeds, which are dark green in color. The leaves of Guinea grass are never streaked with red or yellow, as are those of Johnson grass. Anyone who will note any of these characters need not mistake one for the other. Guinea grass does well on moderately dry soil, growing from 6 to 10 feet high, and is used principally for grazing and soiling.

Guinea grass is propagated either by divisions of the old roots or by seeds. When roots are used the old clumps are dug out early in spring and divided to make as many sets as can be secured with a few fibrous roots attached. When these sets are planted on good ground they will give a good cutting of hay or be ready for grazing in May. Seeds are planted at the same season as the roots, it being the usual practice to plant the seeds thickly in drills and then transplant the seedlings as soon as they are 3 or 4 inches high. Volunteer seedlings are often found in abundance where the old plants have been allowed to mature seed. Sets are more expensive and more troublesome to handle than are seedlings, but will give an earlier and heavier yield the first season. Plants should be set about 2 feet apart in rows 5 to 6 feet apart and should be cultivated three or four times during the season. The grass will live many years without cultivation, but when the ground is not kept loose it makes only a weak growth and does not produce one-fourth the yield which it makes when a cultivator is run between the rows a few times early in the season. When grown without such cultivation the yield is seldom satisfactory. On thin soils a dressing of cotton-seed meal before each cultivation adds largely to the yield. As this grass has no runners or underground stems, it can be killed by plowing out the roots at any time during the winter and has no tendency to become a weed.

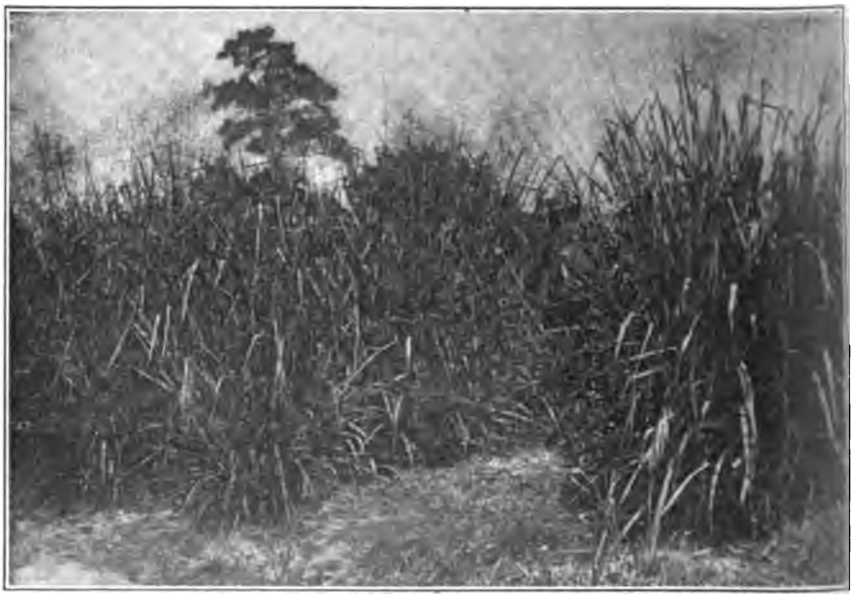

FIG. 4.—Guinea grass, Biloxi, Miss.

Guinea grass begins its growth rather late in the spring, seldom giving much feed before May, but after that time it will give goo cuttings about once every three or four weeks until its growth is checked by frost. In the most favorable part of the season cuttings may be made once in 10 or 12 days, but such rapid growth usually continues only a few weeks. When allowed to stand too long the stalks become hard and woody. This grass makes the best feed if cut when 24 to 36 inches high.

It is difficult to estimate the yield of hay per acre, as Guinea grass is commonly used only for soiling or grazing. Its habit of growing in large clumps makes it difficult to use a machine in cutting this grass for hay. One grower who has used it many years for soiling reports that he can feed 4 head of cattle per acre through the entire season, while another, who is growing cattle extensively, reports that he grazes 3 head per acre through the year, though he also gives his cattle a little Para hay during the winter. A grower in southern Florida says: "It is the best grazing grass we have." Another says: "It yields more than any other grass." Similar statements are made by growers in southern Alabama and southern Mississippi.

The chief value of Guinea grass is as a soiling crop, and it makes more good feed for that purpose than any other grass we have. If cut when only 3 or 4 feet high, the stem is very tender and succulent, nearly the entire growth consisting of rather broad, smooth leaves. When cut at this stage the whole plant is eaten with relish by all kinds of stock. When allowed to grow until it makes seed the stems become hard and woody, though the leaves remain green and are eaten well. It is specially valuable to those who have only small places and who wish a constant supply of green feed for a few horses or cows. Its range of profitable cultivation is about the same as that for Para grass, including the whole of Florida and a narrow strip along the coast westward to Texas south of latitude 31°.

PARA GRASS.

Para grass (*Panicum molle*) (fig. 5), which was introduced from South America many years ago, is now common in central and outhern Florida and is rapidly coming into favor farther west, specially in southern Texas. It is a rank-growing perennial which preads by surface runners, which are often 30 or more feet in length nd which form roots at each joint. As soon as the ground becomes airly covered with these runners the younger stems assume a more rect position, reaching a height of 3 to 5 feet and producing a heavy ield for hay or grazing. Although this grass spreads so rapidly by s long runners, it is more easily killed than Bermuda or Johnson rass, as the runners are wholly on the surface of the ground, and it n be killed by a very shallow plowing followed by a thorough raking. While it makes a fair growth on rather dry soil, it does much better on damp ground and grows well on the margins of ponds and on ditch banks, often reaching out to where the water is 3 or 4 feet deep. It is a desirable species for planting on lands liable to overflows, as it is not killed when covered by water for a month or more.

Para grass produces few seeds (usually none in this country) and is generally propagated by divisions of the runners, which root easily when cut into pieces of 2 or 3 joints each and pushed down into freshly plowed ground so as to leave the upper joint at or just below the surface. When sets are abundant, it is better to put them not more than 2 feet apart in each direction, as such close planting enables the grass to cover the ground more quickly and so induces the erect growth more promptly. When wanted for grazing only, close planting is less important and the sets may be placed 4 to feet apart.

FIG. 5.—Para grass, third year, Kingsville, Tex.

The hay made from Para grass is rather coarse, but is sweet, tender, and nutritious, and the yield is very heavy. One Texas grower reports 6 tons per acre from each of 2 cuttings on a 12-acre field, the second cutting being made in October and followed by excellent winter grazing. Florida growers usually make 3 or 4 cuttings annually, and the hay finds a ready market at the highest price. On grower in southern Florida reports that he makes his first cutting about April 1 and a second cutting about June 1. The ground is then plowed broadcast and harrowed smooth. Two more cuttings are made, in September and November, after which the field gives good grazing until the stock is taken off in March. This is on low ground which is drained by open ditches. The grass makes 2 or more tons of hay at each cutting, and the hay is readily sold to near-by liverymen. Of course such heavy cropping requires liberal fertilizing, but that can well be afforded when a yield of 8 to 10 tons of hay a year is secured, in addition to four months of good grazing. Another grower, in northern Florida, where the grass is more subject to injury by freezing, states that he finds it better to plow the ground in November or December, as the plowing covers portions of the stems, so that they are protected from heavy frosts, and an earlier spring growth is insured.

Para grass is excellent for pasture, is not injured by moderately close grazing or by heavy tramping, and remains green through the entire year, except when cut by frosts. Last year one field of 10 acres in southern Texas gave grazing for 15 cows from April to November, and when the stock was removed the grass was fully 2 feet high and appeared to be growing faster than it was eaten, though the field had not been irrigated during the previous eighteen months. A grower in southern Mississippi reports equally good results from a planting made on low, rich land, and very poor results when planted on high, dry clay. A grower in central Florida states that his field of Para grass gives good grazing for 6 head of cattle per acre at least eight months each year. Another grower, in southern Florida, who has used a few acres of it for pasture a number of years, increased his planting to 100 acres last year, and others in the same section are making similar plantings.

Some orange growers who have Para grass thoroughly established in their groves complain that it makes cultivation troublesome, but as it seldom grows from seed, it is not difficult to hold it in check by the occasional use of a disk harrow. While this grass can be destroyed more easily than some other grasses, it is seldom advisable to plant it in fields which are soon to be used for other crops, but it has great value for making permanent meadows and pastures on wet or even moderately damp soils. As it is killed to the ground by heavy frosts it is not recommended for planting farther north than the northern boundary of Florida, or about latitude 31°.

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Issued June 26, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 301.

HOME-GROWN TEA.

BY

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Scientific Assistant in Tea Culture Investigations,
Bureau of Plant Industry.

WASHINGTON:
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1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 20, 1907.

Sir: I have the honor to transmit herewith an article entitled "Home-Grown Tea," prepared by Mr. George F. Mitchell, Scientific Assistant, and recommend its publication as a Farmers' Bulletin.

This paper was submitted by Dr. R. H. True, Physiologist in Charge of Tea Culture Investigations, at whose suggestion it was prepared in order to meet a considerable demand for information on the methods of growing tea in small home gardens and utilizing it for drinking purposes.

Respectfully,
B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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HOME-GROWN TEA.

HISTORY OF TEA CULTIVATION IN THE UNITED STATES.

A little more than one hundred years ago the French botanist Michaux successfully planted the first tea in the United States. This was at Middleton Barony, on the Ashley River, about 15 miles from Charleston, S. C.

In 1848, Dr. Junius Smith retired from an active life in London to ruralize and plant tea on his estate near Greenville, S. C. Both plants and seed were imported, and in an article in the American Agriculturist for 1851 Dr. Smith stated that his plants were doing finely and had withstood a snow 8 to 9 inches deep on January 3 of that year, and he added: "I can not help thinking that we have now demonstrated the adaptation of the tea plant to the soil and climate of this country, and succeeded in the permanent establishment within our own borders." Dr. Smith died soon afterwards, in 1852, and his plants, without protection, soon disappeared.

As early as 1858, the United States Government, through the Commissioner of Patents, sent Mr. Robert Fortune to China to obtain seeds to be planted in this country. In less than one year's time tea plants were distributed among private persons in the Southern and Gulf States, who later reported that the plants had been successfully cultivated by them and in a great many cases that tea had been made at their homes.

During the year 1880, Hon. William G. Le Duc, then Commissioner of Agriculture, employed Mr. John Jackson, who had been a tea planter for fourteen years in India, to carry on experiments to test the feasibility of growing and manufacturing tea in this country. The experiments were at first conducted in Liberty County, Ga., on a place bought by the Government from Dr. Jones, who had planted tea there in 1850.

Later, 200 additional acres of land near Summerville, S. C., were leased for twenty years from Mr. Henry A. Middleton to carry on these experiments. Seed was imported from Japan, India, and China and was also collected from the few plants then surviving in the United States that had been previously sent out by the Patent Office. From these seeds a small area was planted in tea, but before the plants had a chance to make very much growth Commissioner Le Duc was succeeded by Commissioner George B. Loring, who thought it best, because of the illness of Mr. Jackson and for other reasons, to abandon these experiments.

Since then the cultivation and manufacture of tea on a commercial scale has been practically demonstrated, in cooperation with the Bureau of Plant Industry, by Dr. Charles U. Shepard at his "Pinehurst" tea gardens near Summerville, S. C., where about 100 acres are planted to tea, of which the area in bearing yields about 12,000 pounds of dry tea each year. One of the gardens has yielded as much as 535 pounds of dried tea to the acre during a single season.

Although the distribution of the many plants and the establishment of the many home tea gardens in the South were steps toward encouraging the people to manufacture their own tea, these gardens soon died through lack of interest, because the important point of teaching the growers how to pluck and make the leaves into tea had been neglected.

Experiments were conducted during the summer of 1905 with a view to developing a simple process by which both the green and the black teas can be made successfully by any intelligent person with only such utensils as are found in every kitchen. These experiments indicate very strongly that the result sought can be accomplished and that farmers and others who have enough garden space to grow the plants for use or for ornamental purposes can with very slight expense and trouble make enough tea for their home consumption. It is a significant fact that much of the tea grown in China is planted in the corners and waste places of farms.

CLIMATE REQUIRED BY THE TEA PLANT.

The climate of the Southern and Gulf States is in general admirably adapted to the cultivation of the tea plant. Although the rainfall is much less than in a great many tea-producing countries, the average annual temperature is lower, causing less evaporation and consequently requiring less rainfall. The cultivation of the tea plant can safely be risked where the temperature seldom falls below 24° F. and never goes below zero, and where the annual rainfall exceeds 50 inches, 30 inches or more of this precipitation occurring during the cropping season.

SELECTION OF SOIL.

A well-drained, friable, and easily penetrable clay loam or sandy loam containing a large amount of organic matter is best adapted to the cultivation of the tea plant. Very tenacious undrained soils or very sandy soils that lack water-retaining properties are not adapted to the growth of tea; neither will the plants tolerate stagnant water in the subsoil. The plants being of subtropical origin need as much protection from the cold as possible; therefore, much better results can be obtained where a southern exposure with an abundance of sunshine is selected.

PLANTING.[a]

The seed should be planted in the autumn or winter just before a rain. A convenient place protected from the prevailing winds by a ence, a wind-break, or by the side of a house should be selected and overed with a frame about 6 feet above the ground. (Fig. 1.)

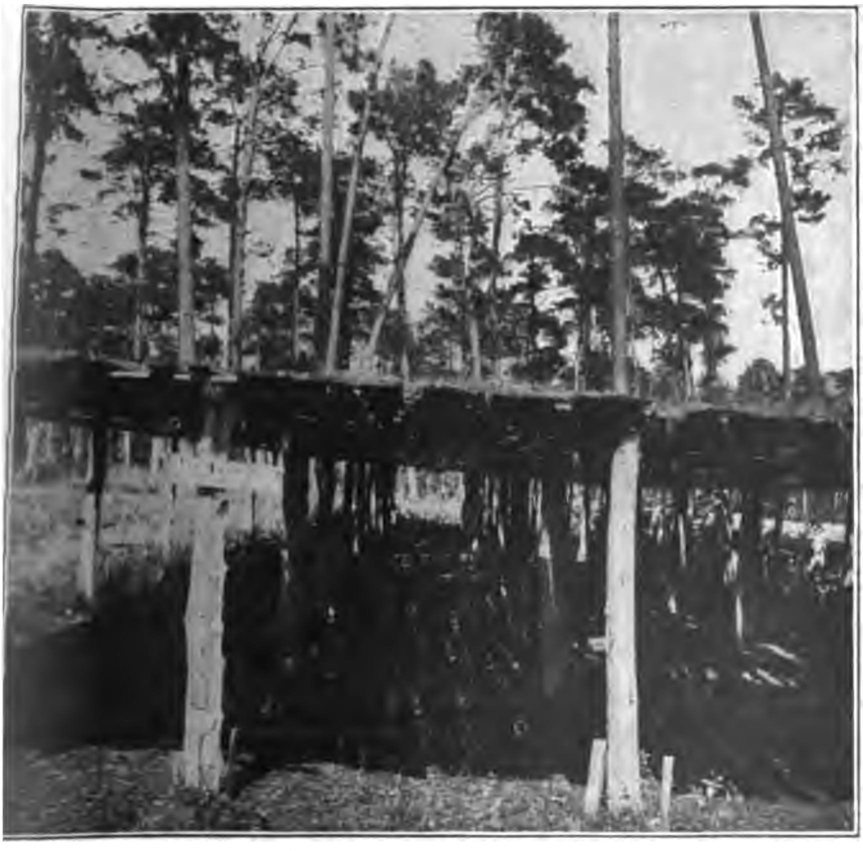

FIG. 1.—Frame erected over seed bed.

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[a] For information concerning the vegetative propagation, veneer grafting, and heraceous grafting of tea, see Bulletin No. 46 of the Bureau of Plant Industry, entitled The Propagation of Tropical Fruit Trees and Other Plants," 1903, pp. 19–23, and ls. VI and VII.

This frame should have cracks about 1½ to 2 inches wide, so as to admit only a little of the direct rays of the sun. It can be made from any waste lumber or loosely woven wire netting covered thinly with straw of some kind.

The soil should be pulverized to a depth of at least 8 inches and entirely freed from grass and roots. The seed should be placed 4 by 4 inches apart in little holes about 1½ inches deep. One seed should be put in each hole and covered by simply raking the surface over gently with a rake.

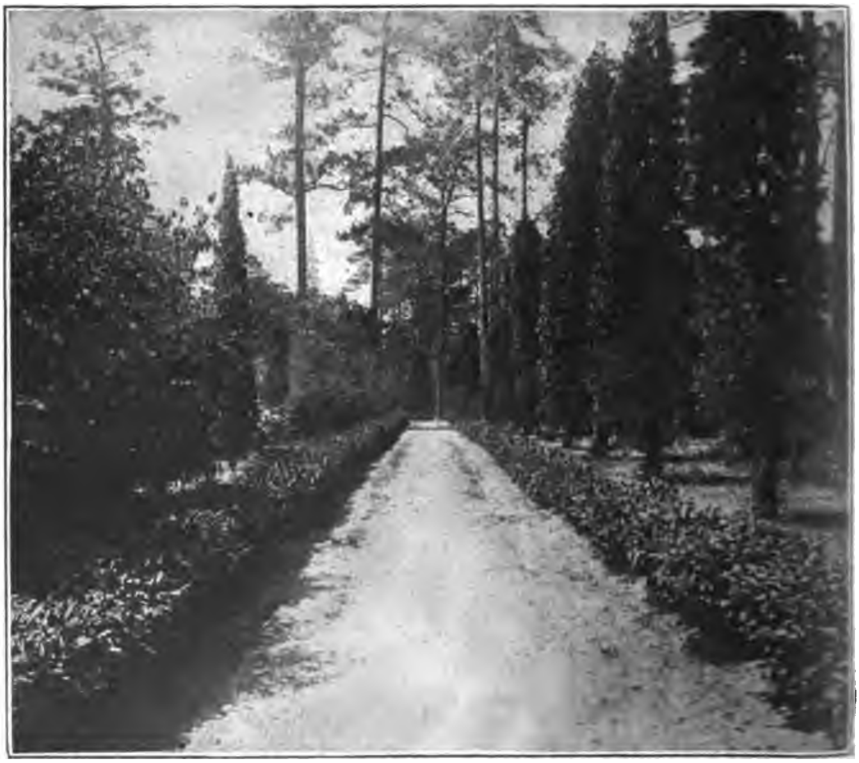

FIG. 2.—Tea plants serving ornamental purposes in hedge rows bordering a walk.

The nursery bed should be covered uniformly with some kind of straw to protect the seed from the cold and also to mulch the bed. Pine straw or needles, if procurable, will be found excellent for this purpose. As the plants begin to shoot above the ground, a little of the straw should be removed from time to time and the nursery thoroughly weeded. This should be kept up until autumn, when the straw should be permanently removed and the top of the frame dispensed with.

When only a few hundred plants are to be raised from seed, a large box 12 inches deep provided with drainage holes and kept protected from the direct sunlight will suffice. In very dry weather, water should be applied to the nursery bed or box either early in the morning or late in the afternoon, when the sun is not very hot.

Seedlings are generally transplanted in the autumn or spring after a heavy rain or when the soil is quite moist to a considerable depth. The plants may be set out twelve to eighteen months from the time of sowing the seeds, although it does no harm to let them remain in the nursery two years, but in such cases their tops should be slightly pruned to prevent them from growing too tall and slender. The plants can either be set 2 feet apart in hedge rows along fences or walks, where they can serve for ornamental purposes (fig. 2), or they can be placed from 2 to 5 feet apart in 5-foot rows.

The soil should be thoroughly pulverized by spading or plowing as deep as possible; then it should be leveled and holes 9 to 12 inches deep made at the proper distances with a trowel or spade. The plants should be placed in the holes with the taproot straight down. In cases where this can not be accomplished owing to extreme length the root should be pruned with a knife or other sharp instrument. The earth should be firmly compressed around the plant, which is best done with the foot. If the soil is rather dry and it seems desirable to water the plants, this should be done.

CULTIVATION.

Frequent and shallow cultivation that will maintain a loose mulch around the plants, as well as keep them free from weeds, is best during the spring and summer, when evaporation is very pronounced, because this shallow mulching breaks the capillary tubes in the soil and lessens the evaporation. In the autumn, after the plucking season is over, the soil should be turned up thoroughly to a considerable depth with a spade or a plow, so that oxidation and disintegration will take place during the winter, when there is very little evaporation.

Commercial fertilizers or barnyard manure should be applied late in the winter or early in the spring and well worked in around the plant but not too near the stalk, because the minute feeding roots which take up the plant food extend some distance from the stem.

PRUNING.

Every February or March after the plants are three years from seed they should be pruned down so that only two eyes are left on the preceding year's new wood. This can be done with either knives or pruning shears, making a clean slanting cut one-half inch above the top eye that is to remain.

Sometimes the plants get very thick after five or six years of service and fall off in their yield; in such cases they should be "collar pruned," that is, pruned to the ground by sawing off the stems. This causes them to put out an abundance of new shoots, which can be picked late in the same season.

In all cases the prunings should be buried in the middle of the rows, as they have considerable manurial value.

PLUCKING.

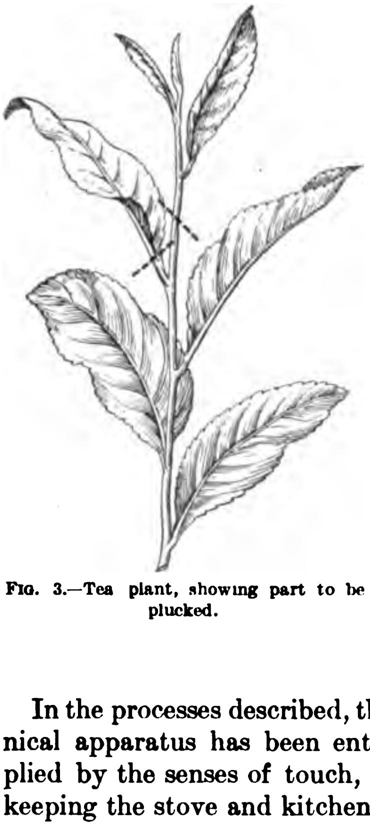

FIG. 3.—Tea plant, showing part to be plucked.

In plucking, which in the Southern States should begin about the first of May and continue until about the middle of October, only the bud (pekoe tip) and the first two or three leaves should be taken (fig. 3), as the other leaves are generally too tough to make good tea. This is done by pinching off the stem with the thumb nail and first finger just under the last leaf to be plucked. The bushes are generally plucked every seven to fifteen days, but this is determined by the development of the tender shoots, care being taken that they do not become too tough before plucking, because then they do not make good tea.

Leaves that are slow in developing always make a better flavored product than those that grow rapidly, so a small yield is always compensated for by a more highly flavored tea.

CURING.

In the processes described, the use of a thermometer and other technical apparatus has been entirely eliminated and their places supplied by the senses of touch, smell, and sight. The importance of keeping the stove and kitchen utensils that are to be used absolutely clean and void of odor of every description can not be too strongly stated, because dry tea readily absorbs any odor that may be present. As only a few utensils are required it is best to obtain new ones and keep them for this purpose only. All that is necessary is a 4-quart double boiler (a saucepan with a hot-water jacket), a larg pan, preferably agate-lined, a large wooden spoon or paddle, and a kneading board where the use of a clean kitchen table can not be ha

BLACK TEA.

The leaves are brought in the day before they are to be made into tea and are spread very thinly and evenly on a clean table or floor, where they are allowed to remain from twelve to twenty-four hours, when they will lose about one-half their weight by the evaporation of moisture, become very soft and flaccid, and feel like an old kid glove. In this condition they are ready for rolling. When withering is near completion the leaves should be watched very carefully, because if allowed to go on too far they become parched and unfit for rolling.

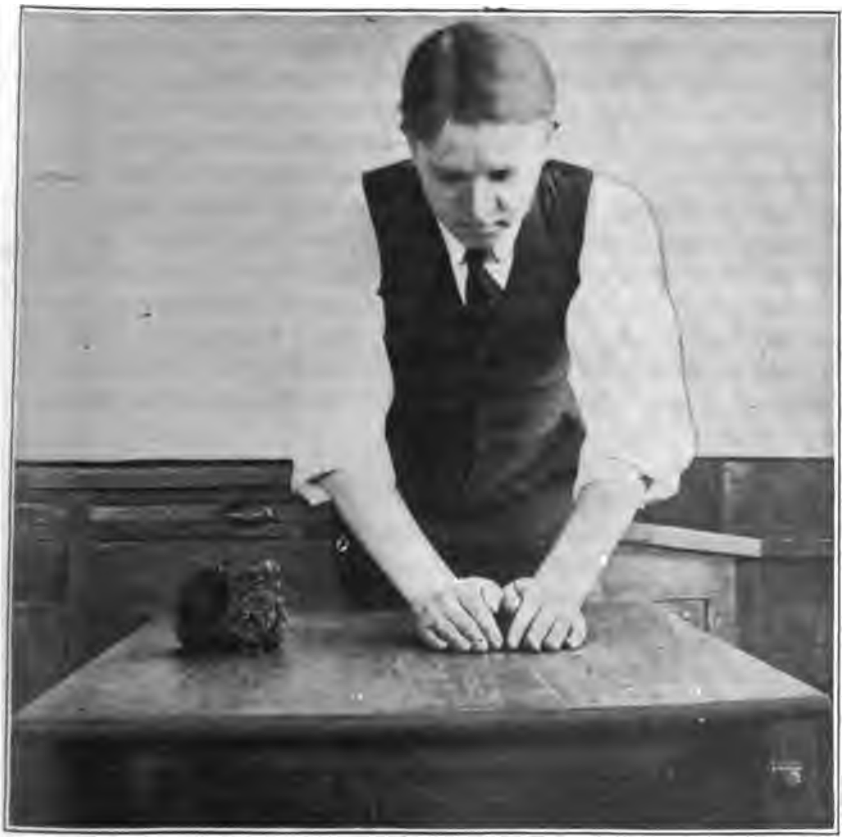

FIG. 4.—Rolling the withered tea leaves.

About half a pound of the withered leaf is rolled or kneaded from twenty-five to thirty minutes on a clean table or kneading board. The operation is similar to the kneading of dough. (Fig. 4.) The rolling should be very light for the first ten minutes so as to allow the leaves to begin to twist or take on the "roll"; then the pressura should be gradually increased until all that can be exerted is applied, so as to express the juice (which should be sopped up with the leaves) and give the leaves a tight twist. This tight rolling not only makes a strong tea but helps to preserve the flavor. Very often the leaves will be a little overwithered and rather brittle, in which case water should be sprinkled on the withered leaves until they are rendered soft enough to roll.

After rolling, the leaves are formed into a "ball" and allowed to remain in a cool and preferably damp place from three to six hours to ferment. The end of this stage in the process is indicated by the ball turning a yellowish copper color, which can be seen when the ball is broken open. The raw herby scent has also changed to an agreeable fruity one. This stage must be watched carefully, because if allowed to go too far the leaves become sour and unfit for tea.

After fermenting, the ball is broken up and spread about half an inch thick in a large clean pan (preferably of agate ware) and placed in the stove oven to dry. The pan should be removed at intervals and the tea turned. This should continue until the tea is very brittle to the touch and a very slight odor of tea is given off. The oven should not be too hot during this operation as too much heat prevents uniform drying. The tea is now ready for use and should be placed in air-tight tin boxes or cans.

SUN-CURED BLACK TEA.

Sun-cured black tea is the same as the ordinary black tea except that the withering is done in the sun in a much shorter time and produces a tea more acceptable to the average taste.

The freshly picked leaves should be spread very thinly and evenly on trays made by tacking cloth on wooden frames of any convenient size, or they may simply be spread on cloths, which in either case should be placed in the sun until the leaves become very flaccid. This will require from one and one-half to three hours, or more, depending on the intensity of the sun's heat and the humidity of the atmosphere. During this operation the leaves should be turned at intervals, so as to induce uniform withering. The further procedure is identical with that already described for the black tea from the point of withering.

This tea is generally made during the months of July and August when the heat of the sun is very intense.

GREEN TEA.

The green tea is made from the same leaves as the black, although some varieties are best adapted to make each of these respective kinds. The green-tea process is the same as that for making bla tea, except that instead of withering from twelve to twenty-four hours and fermenting from three to six hours (when oxidation takes place, which renders it black) the green leaves are quickly brought in and placed in a covered double boiler—that is, a saucepan with a hot-water jacket (one pound of leaf to a 4-quart boiler)—and allowed to remain surrounded by boiling water from seven to nine minutes; the cover should be removed and the leaves stirred at intervals. This will render the leaves very soft and flaccid, ready for rolling. During this rapid process the oxidizing agencies of the leaf are sterilized by the boiling water and steam in the hot-water jacket surrounding the leaves, and the production of a green tea is rendered possible. These flaccid leaves are rolled in like manner to the black tea for about ten minutes, being stirred at intervals until they lose some of their moisture and become sticky; then they are again rolled from fifteen to twenty minutes under all the pressure that can be applied. After rolling they are immediately placed in the oven in a pan and turned t intervals (similar to the black tea) until they are dry and brittle to he touch and a slight scent of tea is given off.

HOW TO PREPARE TEA FOR DRINKING.

Attention must be called to the fact that ordinarily tea is not drawn roperly, which not only makes it less palatable than would otherise be the case but also makes it very deleterious. Chemically, ea leaves yield principally thein and tannin. The former is the ild stimulant that is sought, while the latter should, as far as posble, be avoided. The thein is very soluble and nearly all dissolves water that has been brought to the boiling point and allowed to main on the leaves three or four minutes, whereas if the infusion longer extended only a little more thein is extracted but much ore tannin.

To make tea properly, bring freshly drawn water to a boil, pour it the requisite amount of tea in a previously scalded pot, and allow it remain covered from three to five minutes; then decant or strain to another receptacle. The spent leaves should not be used again cause practically all the stimulating ingredient has been removed d that which is left is very deleterious to health.

CONCLUSIONS.

he cultivation of the tea plant in home gardens is not only profite, but a great deal of pleasure can be derived from it at the same e that the use of the much adulterated foreign article is avoided. is is often found to contain Prussian blue, indigo, turmeric, soapne, and leaves of other plants than tea, some of which are injurious health.

In the autumn this beautiful evergreen plant is covered with handsome, fragrant, whitish flowers, having a golden yellow center, making it an excellent ornamental plant.

The children as well as the older members of the family may derive abundant pleasure in plucking and making the leaves into tea, although the process is so simple that this work can easily devolve upon any intelligent servant.

The crop of an average tea bush is about 3 ounces of cured tea during the picking season, so that 100 plants will yield about 18 pounds a year. As a pound makes from 350 to 400 cups of tea, 50 plants should furnish a cup of tea apiece to a family of nine for every day in the year.

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Issued August 24, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 302.

SEA ISLAND COTTON:

ITS CULTURE, IMPROVEMENT, AND DISEASES.

BY

W. A. ORTON,
PATHOLOGIST, BUREAU OF PLANT INDUSTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 15, 1907.

Sir: I have the honor to submit herewith a paper entitled "Sea Island Cotton: Its Culture, Improvement, and Diseases," which has been prepared by Mr. W. A. Orton after study of the subject for the past seven years.

The paper presents the essential points of a system of culture that should be adopted by growers of Sea Island cotton in Georgia and Florida to overcome the constant deterioration due to lack of seed selection and want of proper care in the handling of this delicate product.

It is desired to acknowledge the assistance received from many planters on James and Edisto Islands, South Carolina; also the active cooperation of the A. P. Brantley Co., of Blackshear, Ga., and of others who have taken part in the experiments carried on in Georgia during the past three years.

I recommend the publication of this manuscript as a Farmers' Bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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SEA ISLAND COTTON: ITS CULTURE, IMPROVEMENT, AND DISEASES.

INTRODUCTION.

Our country can feel a just pride in the Sea Island cotton industry, for it produces the longest, finest, and most valuable cotton grown in the world. Its silky staple is used for spinning fine fabrics and laces and is of paramount importance to the thread industry, which requires a considerable part of the crop. Where great strength and durability are essential, as, for instance, in United States mail bags and in pneumatic tires, Sea Island cotton is also employed. The highly organized and laborious methods of culture, the excellent system of seed selection, and the painstaking care of the product which have maintained the high quality of the cotton grown on the Sea Islands are matters of special interest.

It is quality rather than quantity that gives economic importance to the Sea Island cotton industry, for the total annual production is less than 1 per cent of the American crop, or an average for the past seven years of 94,000 bales per annum.

An improvement in quality, an increase in production, and a greater profit to the acre are all possibilities of the future. They will result from the general adoption of improved methods and the extension over the whole Sea Island cotton belt of the careful system of seed selection and handling now practiced in one portion of the area. On the other hand, conditions are such that the industry may in time be crushed by competition unless the farmers awake to the necessity of considering the needs of the consumer as regards quality and purity and learn that the cost of production per pound can be reduced by increasing the yield per acre and that a diversified cropping system is safer and more profitable than the all-cotton plan.

GEOGRAPHICAL DISTRIBUTION OF SEA ISLAND COTTON IN THE UNITED STATES.

The successful cultivation of Sea Island cotton in this country is confined to the area lying southeast of a line drawn from Georgetown, S. C., to a point in western Florida. The accompanying map, figure 1, shows the approximate quantity produced in each county in this district, each dot standing for 500 bales or a fraction thereof.

In South Carolina the center of production is on the Sea Islands along the coast, where the finest staples are grown. The chief of these islands are James, Edisto, John, and Wadmalaw.

It is interesting to learn that in Georgia the coast counties produce scarcely any cotton, owing to the unfavorable character of the country, the absence of the necessary labor, and the predominance of the lumbering and trucking industries. The interior counties which grow Sea Island cotton extensively also produce considerable Upland cotton.

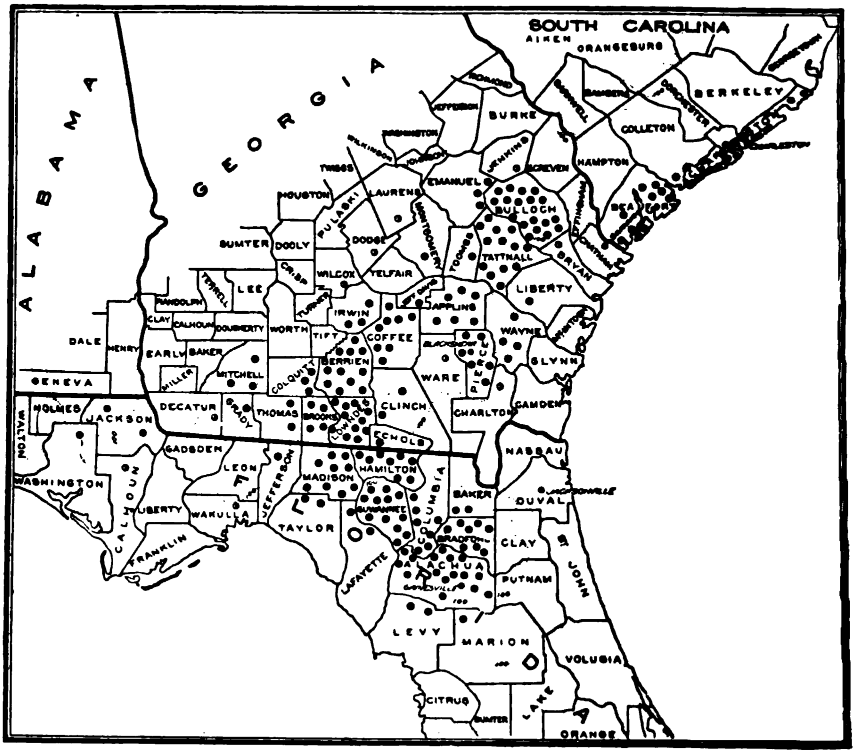

FIG. 1.—Map of the Sea Island cotton area of the United States, showing distribution by counties. Each dot stands for an average production of 500 bales.

In Florida a similar condition exists. Cotton is not grown on the coast, but is confined to the interior counties in the north-central portion of the State. Here the proportion of Upland to Sea Island cotton is much smaller, until one reaches the western counties, where conditions are less favorable for the long-staple cotton and where the Upland type is mainly grown.

The annual crop fluctuates widely, according to the nature of the season, but the average yield in bales of not quite 400 pounds each during the past five years has been as follows: South Carolina, 10,957 bales; Georgia, 50,311 bales, and Florida, 33,749 bales.

IDEAL CROP REQUIREMENTS.

Several factors must be considered when seeking a location for growing Sea Island cotton. Those mentioned here affect not only the yield but the quality of the staple, its color, and the percentage of lint to seed. The relative influence of the various factors is, however, not always determinable.

SOIL.

The crop requires a sandy or a sandy loam soil, preferably with a clay or compact sand subsoil about a foot below the surface. Most of the Sea Island cotton is grown on the soil type classified by the Bureau of Soils as Norfolk fine sand, with lesser areas of Norfolk sand, Norfolk sandy loam, and related types. On the Sea Islands, where a clay subsoil is rarely found, the growers seek to maintain a compacted layer beneath the plants by the tramping of stock during the year the land is resting. The interior growers prefer a clay subsoil, but sometimes plant cotton on quite deep sand, where the quality is satisfactory; the yield is smaller, however, in such cases.

MOISTURE.

A well-regulated water supply is the most important factor influencing Sea Island cotton. Thorough drainage is essential. On this account more and better cotton is grown on the slightly elevated margins of the Sea Islands than in the lower central portions. Tile drains make possible the cultivation of land otherwise too wet. In the interior, cotton is grown only where there is suitable drainage. On the other hand a liberal and regular supply of water is needed, and wherever cotton is planted on the dry hills in the upper edge of the Sea Island cotton belt inferior results are secured, the staple becoming shorter and harsher. The lower lying lands are better, provided they have adequate drainage.

HUMUS.

Soils very rich in humus appear to be unsuited to Sea Island cotton, producing too rank a growth; but a deficiency of humus is also a serious objection, as such land produces a small plant with a tendency to the shedding of bolls and to rust.

LOCATION AND EXPOSURE.

Atmospheric humidity appears to be a prominent factor influencing the quality of the staple. On the Sea Islands, fields having an ocean exposure are said to produce a finer and glossier staple on account of the moisture-laden ocean breezes, and in the interior one advantage of the lower lands is doubtless their moist air, which is conserved by protecting forests and near-by swamps. In the absence of sufficient moisture in the air the staple becomes harsh and shorter. This is further shown by the fact that a wet season is more favorable to Sea Island than to Upland cotton, while the Upland varieties do better in a dry season. The relative production of Upland and Sea Island cotton in the northern counties fluctuates with the season and the changes in acreage due to varying market conditions.

The mixing of seed and the hybridization which result from planting cotton of both types in the same community is a serious handicap to the growers of Sea Island cotton. In this respect portions of Florida where only Sea Island cotton is grown possess a marked advantage, and the introduction of Upland varieties should be discouraged.

LABOR.

In addition to the effect of high prices in stimulating the industry and of low prices in depressing it, a factor which must be considered in connection with the production of cotton in either old or new sections is the supply of available labor. Until present methods are revolutionized a relatively large amount of fairly cheap labor is required, and it is a great advantage if the laborers have had long experience with the crop. Throughout the Sea Island cotton belt there is now a growing scarcity of labor, which is likely to restrict the acreage planted. The farmers must meet the new conditions by the adoption of labor-saving machinery in planting and in cultivation, but there will continue to be difficulty in getting the cotton picked.

The development of trucking and lumbering industries restricts the less profitable cotton crop, and there is a steady exodus of laborers to engage in railroad building, etc., making the labor problem still more serious.

POSSIBLE EXTENSION OF THE SEA ISLAND COTTON-PRODUCING AREA.

It has been predicted that there will be in the future a constant increase in the world's consumption of Sea Island cotton, requiring a corresponding increase in production. Sections outside the present Sea Island cotton belt have from time to time attempted to engage in its culture, but such extensions of area are unnecessary and do not promise a profit. No other portion of our cotton belt is as well adapted to the crop as the area in which it is now grown. This is shown by the fact that during the past hundred years very many attempts have been made to grow Sea Island cotton in other States and all have failed. Such extensions are unnecessary, because several times as much as the present crop could be produced in the area now devoted to Sea Island cotton, if circumstances required it. The increased production could be accomplished in part by clearing and planting new land, for neither on the Sea Islands nor in the interior counties is more than a small fraction of the land under cultivation, and in part by increasing the yield per acre, which could be doubled by better cultural methods and the practice of seed selection. An additional increase would result from the substitution of Sea Island for Upland cotton in the border counties where both are now grown.

Serious obstacles are met with in introducing Sea Island cotton into a new section. There is difficulty in securing the proper care in cultivation and in picking and handling the staple. Pickers accustomed to Upland varieties object so much to the small and partly closed Sea Island bolls that it is difficult to get the cotton picked even at the prices now paid—$1 to $1.25 a hundred pounds. The ginning must be done on a roller gin, as the saw gin injures the staple too much, and a specially equipped ginnery is therefore necessary. Further difficulties are met with in marketing the product, which at first can rarely be sold to advantage in a local market where the buyers are unaccustomed to the Sea Island staple. Shipment to a recognized market for Sea Island cotton is necessary in such cases.

MARKETS.

The cotton grown in South Carolina is marketed at Charleston, while the interior crop is handled at Savannah, Blackshear, and Valdosta, Ga., Madison, Fla., and other interior towns. There is a marked difference in the style of bale in the two cases. South Carolina cotton is put up in bags, 7½ feet long and about 2½ feet in diameter, containing 300 to 400 pounds. (Fig. 2.) They are filled by hand and pressed in a light hand-screw press. Compression for export is not practiced. As the use of this bag has been confined to the Sea Islands, it serves as a trademark to distinguish the crop in foreign markets.

In the Charleston district the finest cotton is that grown by a limited number of planters who have for many years paid the most careful attention to seed selection. Their cotton is not only long and fine but is picked with so much regard to cleanliness and uniformity that the grower's private brand on the package is often a sufficient guarantee of its quality.

These fine "crop lots" comprise about 35 per cent of the cotton marketed in Charleston and sell for from 30 to 60 cents a pound. They are all exported. The demand for this extra-fine and high-priced cotton is very limited. The remainder of the South Carolina crop is sold in the usual manner at lower prices. The higher price secured for South Carolina cotton is largely because of its superior preparation, all stained and weak cotton and bits of leaf being removed before baling.

Interior Sea Island cotton is packed by a steam press into bales weighing about 400 pounds each, of the same shape and size as an Upland cotton bale, 54 inches by 27 inches (fig. 3). They are covered with heavy burlap, secured by sewing with strong cord instead of by the steel ties used on bales of Upland cotton.

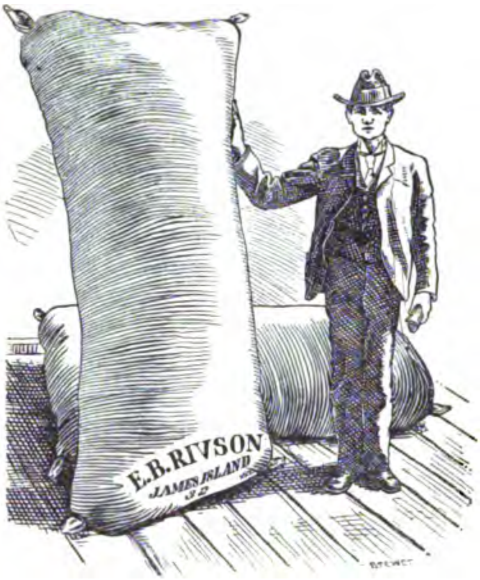

Fig. 2.—Bag of Carolina-grown Sea Island cotton, showing the style of package used on the Sea Islands.

The buyers classify interior cotton first by length of staple into "East Floridas," 1¾ inches to 2 inches; "Floridas," 1⅝ inches to 1¾ inches; and "Georgias," 1½ inches but less fine than Floridas. These names have come to be applied without regard to the source of the cotton. The length of staple is mainly influenced by seed selection, but in part by the character of the soil. Each of these classes is subdivided into grades with reference to its preparation and appearance, the usual grades being fancy, extra choice, choice, extra fine, fine, and "dogs." The difference of 5 to 10 cents a pound between fancy and fine shows the possible gain to the farmer from careful preparation. Loss of grade is due to exposure to weather before picking, to storing or ginning when too wet, and especially to the presence of stained or yellow cotton and bits of leaf or other trash.

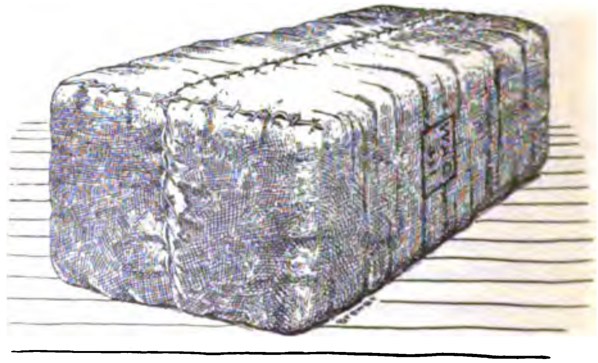

Fig. 3.—Bale of interior-grown Sea Island cotton, showing the style of package used in Georgia and Florida.

FACTORS GOVERNING PRICES.

There is a fairly uniform demand for a few hundred bags of extra fine cotton with staple of 2 inches and over, and, for what the marke requires, a high price, 50 to 80 cents a pound, will be paid. A larger quantity of this long-staple cotton is difficult to sell at any price. For the medium grades (1⅝ inches to 1⅞ inches) there is a liberal demand at prices determined by the law of supply and demand. The size of the crop in Georgia and Florida is the principal factor in establishing the price, but other long staples exercise considerable influence.

Sea Island cotton is only slightly affected by the fluctuations of short-staple Upland cotton, but the amount and quality of the long-staple Upland crop seriously affect the lower grades of Sea Island cotton. Staples less than 1⅝ inches long sell well only in a year when the long-staple Upland crop is inferior. This long-staple Upland cotton is grown mainly in the Mississippi Valley, and as it can be produced at a less cost than Sea Island cotton it is evident that the latter must not be permitted to become less than 1⅝ inches in length, in order to avoid this competition.

The next quality of staple competing with Sea Island cotton is the Egyptian. Of this an amount equivalent to about 1,500,000 Sea Island bales of 400 pounds is produced every year in the Nile Valley, and 147,000 such bales are annually imported into America. An average price is 15 cents a pound. Egyptian, while not as long and fine as Sea Island cotton, is very strong and free from waste, owing to careful preparation. It wastes in the mill 8 per cent less than Sea Island cotton, the average waste in the different processes of preparing for spinning being 33 per cent for the Sea Island and only 25 per cent for Egyptian. Much of the Egyptian cotton is decidedly shorter than Sea Island, but the Jannovitch variety and to some extent the Abassi are, in particular, competitors of Sea Island of 1⅝-inch staple or less and will continue to be used in preference to the American product, even in our own mills, until the interior Sea Island growers improve their product.

Mr. A. P. Brantley, a well-informed buyer and exporter of Sea Island cotton, writes as follows:

> Jannovitch has, during the last few seasons, commanded practically as much money as Extra Choice and Fancy Georgias. If, however, we could produce cotton with staple of 1⅝ inches which would not show a spinning loss of more than 25 per cent as compared with 33 per cent, the present average loss, and if at the same time we could grow a cotton with fewer neps, there would be a tremendous expansion in the demand for this style of cotton, for the reason that it is slightly stronger than Jannovitch; but as the case stands now Jannovitch is preferred at an even price in many cases on account of its being less wasty and having fewer neps.

The Egyptian, although closely related to Sea Island cotton, can not be grown successfully in our southeastern States on account of its susceptibility to the bacterial disease "black-arm."

Sea Island cotton produced in the West Indies is equal to the average American product, and indeed competes with the Carolina Sea Island cotton rather than with the interior product. The West Indian industry is new, having been developed mainly since 1902, and is as yet of small proportions, only about 4,000 bales per annum being produced; but the industry there may grow rapidly. It has already led the South Carolina planters to organize in refusing to sell seed.

The Sea Island grower will therefore recognize that the prices of his crop depend on several factors and that quality is more important than quantity. Organized efforts should be made to raise the standard of length and preparation in order to avoid competition with cheaper cotton. Of the better grades a larger quantity can be sold than is now produced.

Interior planters are advised not to aim to produce an extra long cotton. South Carolina and the West Indies can excel in this, and the market for such cotton is very limited. Furthermore, the increase in length is obtained at a sacrifice in yield which cancels the profit. Rather let the interior grower select for a staple 1⅝ inches to 1¾ inches long and for a vigorous and productive plant, and let the campaign for a reduction of acreage be directed against staples less than 1⅝ inches in length and against the planting of Upland cotton in Sea Island districts.

FARM PRACTICES.

On the Carolina Sea Islands the planters have worked out a system well adapted to the peculiar needs of that section. Their methods are in many respects excellent, and the recommendations in this bulletin regarding improvements apply less to these growers than to those in Georgia and Florida, where a brief survey will convince one that far greater profits could be secured by radical changes in farm practices.

SEED SELECTION THE FIRST REQUIREMENT.

Without seed selection Sea Island cotton can not be grown successfully for more than a few years in any latitude. The interior growers have always depended on the skillful seed selection of the Carolina planters and have continued to neglect the matter since this seed supply has been cut off by a growers' organization. No more improved seed can be had from the Sea Islands, and nothing is more certain than that the crop will continue to deteriorate rapidly until the interior growers begin work to improve it. They undoubtedly will rise to the occasion when they realize that their industry is at stake. They may be assured in advance that they will succeed to a degree limited only by the care and skill they expend.

Three points are to be sought by selection, as follows:

(1) Length and quality of staple must be maintained. Only by saving seed from plants having a long, fine, and uniform staple can these qualities be retained. Otherwise there occur in the fields an increasing number of plants with a shorter staple, due to the inherent tendency of this highly improved crop to revert to its original character. The farmer overcomes this tendency when he chooses his seed each year only from stalks that have maintained the desired quality.

(2) Good productive plants must be secured. A greater loss than farmers realize is due to the number of unproductive plants in every field. Even plants equally supplied with space and food differ much in the number of bolls they bear, the size of the bolls, and the way they open. These differences are mainly inherited, so that by careful attention to this point when selecting seed the producing power of any variety can be greatly increased.

(3) Run-out and hybrid plants must be eliminated. A conspicuous source of loss in the average interior field is the number of tall hybrid and run-out plants. These occupy double the space of good ones and yet produce a worthless crop. All such plants should be pulled out as soon as detected. Where careful seed selection is practiced and the neighborhood of Upland cotton avoided, very few of these undesirable plants will appear in the crop.

PREPARATION OF THE STAPLE FOR MARKET.

Next in importance to seed selection is the preparation of the staple for the market. Interior-grown Sea Island cotton has an unenviable reputation for poor preparation as compared with the Carolina Sea Island product. The farmers seem not to consider the delicate nature of the staple and handle it as carelessly as they would Upland varieties, whereas it requires special care at every stage from boll to bale. Too often it diminishes in value by exposure to weather in the field, by being mingled with broken leaves and yellow cotton in picking, by being stored undried when gathered damp, or by careless ginning. The luster of the staple once lost can never be regained. The admixture of weak and stained cotton means loss to the spinner from waste and the extra cost of cleaning, and this loss must be made good by a reduction in the price paid the farmer.

There is much complaint from the spinners of an undue amount of nep, or white knots of tangled fibers in cotton from diseased plants, or in cotton picked too green or not properly ginned. Much of this trouble can be avoided.

BETTER CULTURE MEANS LARGER CROPS.

The fact that the yield on some farms averages 400 pounds of lint per acre while the general average is perhaps less than 100 pounds per acre shows that there can be a great improvement in methods of growing the crop. The Sea Island cotton belt needs to diversify, to rotate crops, to use fertilizers more rationally, to build up the thin soil, to plow deeper and cultivate shallower, and to economize hand labor by modern farm machinery.

CREDIT AND THE RENTAL SYSTEM A BAR TO PROGRESS.

The cost of cotton production is greatly increased by the prevailing credit system, owing to the higher cost of supplies and the reduction of the farmers' ambition and efficiency. The rapid change from credit to a cash system now going on is a great gain for good farming.

The common practice of renting land for a share of the crop greatly hinders the adoption of improved methods. It means instead the continuous planting of cotton without attention to seed selection or soil improvement. When the owner can not operate his farm himself, he should retain strict oversight over the work done by his tenant and provide, through a written contract, for a specified system of rotation and seed selection.

If the period of rental were three or five years instead of one, there would be more incentive for the tenant to build up the soil. The owner who keeps his land in a high state of cultivation has no difficulty in securing the best class of tenants.

DEFECTS IN MARKET CONDITIONS.

There is a tendency among cotton buyers to pay an average price for all grades of Sea Island cotton, especially in the smaller markets. This means that good cotton brings less than its value, and inferior or dirty cotton too much. This practice is an injustice to the farmer who produces a superior article and it tends to discourage him from selecting for quality. Unless buyers are willing to pay full value for the best cotton, farmers can not be expected to improve their seed in any respect except to secure larger yields per acre.

It is an advantage to the farmer who has a superior grade of cotton to secure competitive offers from large buyers before selling. In this direction much good can be done by farmers' organizations.

CULTIVATION OF SEA ISLAND COTTON.

ROTATION AND DIVERSIFICATION.

Although Sea Island cotton always has been grown on the one-crop plan even on the Sea Islands, there are many reasons why greater success can be had by making it a part of a system of diversified farming. By rotation of crops several purposes are accomplished, as follows:

(1) The productive capacity of the land is increased and maintained. The cultivation of cowpeas, velvet beans, and other legumes adds to the soil large quantities of nitrogen drawn from the air, enabling the farmer to secure at slight expense an element which is the most costly part of purchased fertilizers.

The physical condition of the soil is improved, especially by the addition of humus or vegetable mold, whereas continued cultivation in cotton or corn rapidly exhausts the humus. The importance of humus can hardly be overestimated. A soil rich in organic matter is more easily cultivated than other soil. It suffers less from washing because the water is absorbed, and because of this water-holding power it does not quickly become too wet, nor does it dry quickly; hence, injury from drought is lessened. A soil rich in organic matter is richer in the beneficial bacteria and other organisms that take part in rendering available to the plant the food hitherto locked up.

By rotation, crops with different fertility requirements are alternated so that the same elements are not drawn on so constantly. Cover crops which increase humus can succeed cultivated crops which exhaust it, and in the intervals of rotation any poisonous or injurious excretion from the roots of a crop is neutralized. Deep-rooted crops may be employed to bring up plant food from the subsoil and leave it at the surface when they decay, where it will be available for shallower rooted crops.

The test of successful farming is to produce large and profitable crops and at the same time to build up the fertility of the soil, making it each year more productive. Diversified farming permits this to be done; continuous cotton growing never will.

(2) A diversified cropping system places farm operations on a safer and more economical basis. Regular and continuous employment for labor is secured if crops are grown which require attention at different seasons. The danger of loss from unfavorable weather or glutted markets is much diminished when several crops are grown. It is particularly important that the growers of Sea Island cotton should begin at once to practice diversification in order to gain experience with other crops, because there is a possibility that the invasion of the boll weevil into the eastern States may in a few years make Sea Island cotton an unprofitable crop. Much hardship will result unless other crops are established meantime.

(3) Rotation of crops is one of the most effective means of controlling weeds, insects, and plant diseases. Crab-grass, nut-grass, and other weeds troublesome in cotton fields are reduced in numbers by the shading and smothering effect of a heavy growth of cowpeas or velvet beans. Most injurious insects and plant diseases attack only

one kind of plant. The continuous culture of any crop affords ideal conditions for the multiplication of its pests, while rotation of crops results in their destruction from lack of food.

For example, the nematode worm, causing the destructive root-knot of peaches, cotton, etc., is greatly increased by planting susceptible crops, but can be controlled by a succession of immune crops, such as corn, oats, velvet beans, or peanuts. For several cotton diseases, including anthracnose, boll-rot, and "black-arm," rotation is advised as one of several preventive measures.

Rotation Systems.

The term "rotation" implies a prearranged order of succession for the various crops cultivated. Every farmer should draw up a planting scheme for his farm, worked out with reference to the relation of each crop to the others. The details of this plan will differ in every case according to the number of crops and the acreage of each, but some general principles apply to all.

The crops in a rotation may be divided into two classes:

(1) Money crops, in the majority of cases Sea Island cotton or corn, from the sale of which the principal income is derived. These draw from the soil more than they add to it.

(2) Improvement crops, grown mainly to build up the soil. These are usually legumes, like cowpeas, velvet beans, peanuts, or beggarweed. If fed to stock they will return a revenue and improve the soil as well.

The choice of a legume.—Cowpeas have always been the most popular and widely grown crop of this class. They have many advantages over the others—adaptability to poor land, ease of culture, the value of the peas as food for man or stock, excellence as a hay crop, etc. On the other hand, they are open to the serious objection that they are very subject to root-knot and greatly increase this disease. On land infected by cotton wilt or black-root the loss is increased by the presence of root-knot. Fortunately the Iron cowpea is immune to root-knot and can be used with safety. In fields where it is certain there is no root-knot any pea can be planted, but the trouble is that root-knot frequently appears where its presence was not suspected. As all Sea Island cotton lands are sandy and subject to infection by root-knot and wilt it is urged that no other cowpea than the Iron variety be used in rotation with Sea Island cotton.

Velvet beans are a great addition to the resources of Sea Island cotton growers. They are entirely immune to root-knot and black root and of much value in rotations for this reason. No other legume grown in the Sea Island cotton belt makes as much growth or adds as much vegetable matter and nitrogen to the soil. Velvet beans afford excellent grazing for stock in late fall and winter, and should be grown much more than at present. Their long season of growth is a disadvantage when a catch crop is needed to follow potatoes or grain. The vines are so long that harvesting for hay is nearly impossible.

Peanuts, or ground peas, are also free from root-knot, and are especially useful as feed for hogs. They appear to be somewhat less effective as soil improvers than cowpeas.

Beggarweed is native to Florida and seeds itself whenever permitted to grow. It makes a valuable hay when cut at the beginning of the blooming season and does good service in enriching the soil. In the cotton field it must be kept under control by thorough cultivation or the seeds will become tangled in the cotton, but if allowed to spring up late in summer it will serve as a winter cover crop to the great benefit of the land. The complete immunity of beggarweed to root-knot is an important point in its favor.

Resting land.—A practice common on the Sea Islands and in portions of Florida is to plant cotton alternately on half the farm, leaving the other half to grow up in grass and weeds. This is much better than continuous cotton planting, but is a defective system because the maximum capacity of the land is not obtained. It is better to grow a useful legume than coarse or obnoxious weeds, like fennel, coffeeweed, and sandspurs, or if pasture is needed rye may be sown between the cotton rows in the fall, grazed during the spring months, then plowed under and Iron cowpeas sown for hay or for fall grazing. Thus there may be substituted a two-year rotation, which is perhaps the most practicable plan for the conditions now prevailing. The two-year rotation in its simplest form is cotton on half the land and corn and Iron cowpeas on the other half, the cotton following the corn and peas each year. A better plan is to plant one-half of the land in cotton, one-fourth in corn and Iron cowpeas, and one-fourth in velvet beans, reversing the order so that velvet beans come on the same land once in four years, cotton twice, and corn and peas once. This is practically a four-year rotation. If, after this has been repeated several times, the land becomes too rich in nitrogen, as indicated by an excessive growth of the cotton to weed, the velvet beans could be omitted for a year or two. Velvet beans or cowpeas in these rotations should be fertilized with about 200 pounds of acid phosphate and potash to the acre. No nitrogen is required.

A three-year rotation is better than one of two years. The three-year rotation for the first year might consist of rye, oats, or wheat for hay, followed by Iron cowpeas; second year, corn with Iron cowpeas; third year, cotton. Cut the corn when ripe and shred the stalks. Do not waste time pulling fodder. Cut the peas for hay or pasture them. In early fall plow under the stubble and sow rye, oats, or wheat. This grain should be cut for hay just before it ripens, and should be off in time to plant velvet beans, if they are preferred to cowpeas. The field should be grazed during the fall, and the remaining litter plowed in early enough in the winter to decay before the cotton is planted. The advantage of the three-year rotation is that it permits keeping more live stock and will consequently improve the land more rapidly.

FERTILIZERS FOR SEA ISLAND COTTON.

PRESENT PRACTICES.

The character of the fertilizers and the amounts used per acre by farmers in different parts of the Sea Island cotton belt vary between wide extremes. The practices on the Sea Islands are characterized by heavy applications of home-mixed fertilizers, differing considerably in composition according to the ideas of the various planters, but usually rich in potash. The need for humus is recognized, and is supplied by growing cowpeas and by heavy applications of marsh mud, salt water grass, and compost. Three typical examples follow: (1) Two hundred pounds of kainit, 200 pounds of acid phosphate, 400 pounds of cotton-seed meal, 25 bushels of Sea Island cotton seed, 25 loads of marsh mud per acre; (2) 200 pounds of kainit, 200 pounds of acid phosphate, 200 pounds of lime, 1,000 pounds of Sea Island cotton seed per acre; (3) 300 pounds of kainit, 300 pounds of acid phosphate, 300 pounds of cotton-seed meal per acre.

In Georgia and Florida, on the other hand, light applications predominate. Occasionally, however, a farmer goes to the other extreme and puts on 1,000 to 2,000 pounds of fertilizer per acre. A common practice is to use a complete fertilizer of the 2–8–2 grade,[a] applying 100 to 250 pounds per acre. Some planters, however, use only acid phosphate and potash, while others use nothing but kainit.

GENERAL PRINCIPLES GOVERNING THE USE OF FERTILIZERS.

The fertilizer question is too complex to discuss fully here. Farmers' Bulletins Nos. 44 and 48 contain detailed information on this subject, and will be sent free of charge to any person requesting them. A few general rules to be remembered are the following:

(1) The best results from the use of fertilizers can be had only when the soil has been put in first-class physical condition by deep plowing and the addition of vegetable matter.

(2) Stable manure and compost made on the farm are cheaper and far more effective and lasting than commercial fertilizers.

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[a] This means that the fertilizer contains 2 per cent of ammonia, 8 per cent of phosphoric acid, and 2 per cent of potash.

(3) The market value of commercial fertilizers is based on the nitrogen, potassium, and phosphorus they contain. The farmer should buy only the quantity of each element that will give the most profit on his soil.

(4) The amount of each element required varies with the soil so much that two sides of the same field often require different fertilizing.

(5) The proper fertilizer formula can not be told from a chemical analysis of the soil or of the plant, but an opinion can be formed from the appearance of the crop and verified by field trials.

(6) More plant food can be purchased for a given sum in high-grade fertilizers than in low-grade brands. Buy the best and use less per acre.

Effect of Nitrogen.

Sea Island cotton requires less nitrogen than most crops, especially on low or moist soils. All excess of this element stimulates vegetative development, resulting in tall, coarse, and relatively unproductive plants, with large, dark-green leaves. A lack of nitrogen is shown when plants are small, with a light yellowish-green cast of foliage.

The usual sources of nitrogen, or ammonia, are cotton-seed meal, dried blood, tankage, fish scrap, nitrate of soda, and sulphate of ammonia. It is the most expensive ingredient of fertilizers, costing 16 to 18 cents per pound as compared with 4 to 5 cents for potash and phosphoric acid, and for that reason should be supplied mainly by rotation with legumes. The effect of cowpea or velvet bean stubble plowed under at the Alabama Agricultural Experiment Station was to increase the next year's cotton crop 63 per cent, this figure being the average of four tests. In such cases it is often unnecessary to purchase nitrogen, except that it may be profitable to apply about 50 pounds of nitrate of soda before planting to stimulate the young seedlings to rapid growth. When commercial fertilizers are relied on, the nitrogen is best derived from cotton-seed meal or other organic materials, such as tankage or dried blood, which become available more slowly and are more lasting in their effects than the quickly soluble nitrate of soda or sulphate of ammonia. An exception should be made in the case of land subject to the blue disease, as stable manure or other organic fertilizers, unless very thoroughly decayed, aggravate this trouble. (See page 48.)

Effect of Potassium.

A liberal supply of potash is very important for Sea Island cotton, and farmers outside of the Sea Islands use too little of it. Potassium influences the formation of starches and sugars in the plant and appears to be indispensable for protein formation. A lack of it in the case of Sea Island cotton may lead to the appearance of "rust," a disease resulting from disordered nutrition. Fields or parts of fields known to be subject to rust should receive an additional application of potash in amounts varying in accordance with the severity of the disease (see page 48). Kainit is the most common source of potash, but as it contains only 12 per cent of potash it should be applied liberally. Muriate of potash containing 48 per cent of potash is more convenient on account of its concentration and is usually considered to be proportionately effective. Fifty pounds of muriate of potash per acre would thus be equivalent to 200 pounds of kainit.

Effect of Phosphorus.

This element in the form of phosphoric acid compounds is indispensable to the Sea Island cotton plant for its general development, and especially for the seed and lint. Most soils are deficient in phosphorus, which is therefore an important ingredient of fertilizers. Acid phosphate is the usual source, and on account of its low price forms an unduly large proportion of the average fertilizer.

Lime Usually Unnecessary.

With the exception of occasional applications of marl on the Sea Islands, lime is not used by cotton growers and there is little evidence that it would be profitable.

The Best Formula.

From the foregoing it will be understood that no fertilizer formula can be given that will fit all cases. The following is suggested, subject to modifications as the conditions vary: Nitrogen, 3 per cent; acid phosphate, 8 per cent; potash, 4 per cent. A ton of fertilizer having approximately this composition could be made from acid phosphate, 1,050 pounds; cotton-seed meal, 750 pounds; nitrate of soda, 62 pounds; muriate of potash, 138 pounds. The potash should be increased on land liable to rust, and the nitrogen increased or diminished according to the size of weeds the land will produce.

Quantity to the Acre.

The aim may well be to apply the maximum quantity of fertilizer that will return a sure profit. This will vary according to circumstances and can be determined only by experiments made on each farm. Two hundred pounds per acre is too little in almost every case, and if more than 1,000 pounds per acre are applied some of the fertilizer is likely to be wasted, particularly on thin land. The better the soil in tilth and the richer in humus the more fertilizer can be used.

Methods of Application.

Where less than 400 pounds of fertilizer per acre are used, it is probably best to apply all in the drill at the time of planting. . For larger quantities many farmers prefer to divide the application, putting part in at the time of planting and the remainder during cultivation in June.

PREPARATION OF THE LAND.

Thorough clearing of the land, including the removal of all stumps, is essential for the use of modern plows and cultivators. The next requirement is drainage. If the land is wet or subject to overflow, it must be drained. This can be done by open ditches, but tiles are better. Farmers' Bulletin No. 187, on this subject, will be sent upon request. Many planters on the Sea Islands have greatly increased the producing capacity of their fields by drainage and have also much reduced the danger of loss from excessive rains.

RIDGE CULTURE.

On the Sea Islands cotton is invariably grown on ridges, or beds, 5 feet apart, as indicated in the accompanying diagram (fig. 4). The method of forming and handling these beds is briefly as follows: Beginning in January the old stalks are broken down, the limbs and trash raked into the alleys, and the coarser litter burned. In February cotton seed is strewn in the alleys at the rate of 1,000 pounds to the acre, and a compost of stable manure, pine straw, marsh grass, and other refuse applied to as much of the field as the quantity obtainable permits, giving preference to the poorer portions. With a two-horse plow a furrow is turned in from each side to cover the compost and seed. In late February or in March the commercial fertilizer is drilled in at the rate of 600 to 1,000 pounds per acre and covered. The beds are rolled with a double roller (see fig. 5) before planting. Strips of wood on these rollers mark the position of the hills. Planting is usually done by hand, sometimes with a planter. When the cotton is well up it is cultivated with a sweep and hoed by hand, the dirt being drawn around the plant. Cultivations and hoeings alternate. The cotton is worked every week—eight to ten times in all. Thinning begins when the plants are 5 to 6 inches high and is done gradually until only one plant is left in a hill. The cotton is laid by in July or August, when it becomes too large to work without injury. The plants are then growing on broad beds separated by alleys about a foot deep.

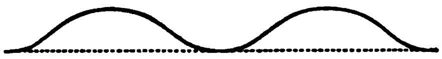

FIG. 4.—Cross section of the beds on which cotton is grown on the Sea Islands.

While level culture is generally practiced in Georgia and Florida at the present time, it is quite likely that a modification of the South Carolina broad bed would be more profitable. This ridge system gives better results in two classes of cases, as follows:

(1) On low and poorly drained land, where it permits greater root development on account of the improved aeration of the soil.

(2) When, on account of the land being rich and well fertilized, Sea Island cotton grows too much to weed under level culture. In such cases the grower is compelled to adopt measures to turn the energies of the plant from vegetative growth to fruiting. This is done by restricting the root development, (1) by maintaining a compact subsoil, which the Sea Island planters accomplish on their deep sandy soils by pasturing with cattle during the year of rest; (2) by regulating the moisture supply by the high beds, and (3) by root pruning by deep cultivation if the cotton needs it. It is also believed by the Sea Island planters that ridge culture permits better control of nutgrass, as this pest can be kept down more successfully by covering it with earth than by cutting it up.

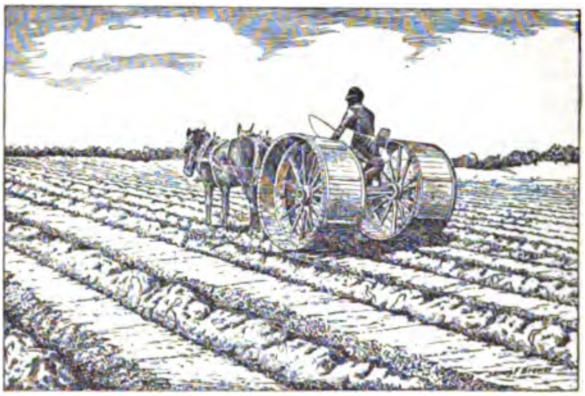

FIG. 5.—Double roller used on the Sea Islands to prepare the beds for planting cotton. The strips of wood mark the location of the hills.

The ridge system has its limitations and disadvantages, which must be borne in mind. It will not do for light and droughty soils deficient in vegetable matter and scantily fertilized, where the cotton plants would suffer from lack of moisture. Such soils should first be built up by a course of green manuring. The greatest disadvantage of the ridge system is the increased cost of cultivation due to the hand labor required to draw the earth around the plants. This objection can and must be met by the introduction of improved implements for cultivating which will work the beds without hand labor.

Interior farmers are advised to test the ridge method thoroughly after carefully studying the subject and adapting it to their conditions.

LEVEL CULTURE.

If level culture is preferred, the following instructions will apply:

Plowing should be Deep.

It is advised that the land be broken broadcast, with a two-horse plow, 6 to 8 inches deep, or as deep as practicable under the circumstances. In very shallow soils only an inch or so of the subsoil should be turned up at once, but by plowing an inch deeper each year such a soil can be deepened. Subsoiling has its advocates and may be profitable in some cases, but for the average Sea Island soil it is not recommended. If practiced at all, it should be for the corn or other crop preceding cotton in the rotation.

Vegetable Matter should be Plowed In.

All vegetable matter on the land and all that can be put on it should be plowed under in early winter, when it will have time to decay. The remains of a velvet bean crop, or grass, weeds, cornstalks, etc., all greatly improve the land.

The common practice of burning over land before plowing can not be too strongly condemned. It means the deliberate destruction of fertility worth more than the farmer can afford to purchase and the loss of the humus that should be conserved by every possible means. An exception to this rule should be made if boll-rot or black-arm has been troublesome. Diseased stalks should be burned to prevent the infection of the next crop.

Fertilizing and Bedding.

Having broken the land broadcast, apply the fertilizer with a fertilizer distributer in drills the proper distance apart. Bed over this with a disk harrow or with plows in the usual way.

Planting.

Plant with a good machine, preferably one that will drop the seed in hills at the desired distance, and thus save labor in chopping to a stand. A good distance for average conditions is 20 inches apart in 5-foot rows. The plants should finally be thinned to one in a hill. One plant every 20 inches will bear more cotton than two in the same space. It is furthermore very difficult to judge the plants properly when selecting seed if two plants grow in the same hill.

Time of planting.—It is advised that planting be begun as early as the season permits. This varies in different years and sections from March 15 to April 10. Early planted Sea Island cotton is found to make a more compact and fruitful plant, while late cotton tends to form a larger and coarser weed.

Long experience is required to judge truly the best time for planting, for the southern spring is variable and uncertain. On the one hand the cotton must escape frost, and on the other the spring droughts. Should dry weather prevail before planting is completed, the seed should not be put into the ground until there is ample moisture to bring it up, as otherwise it is likely to perish. Soon after the cotton comes up replant all missing hills. Every effort must be made to obtain a perfect stand. Every missing hill reduces the crop, while the cost of cultivation is the same as for a full stand.

Cultivation.

With level culture a weeder can be used to advantage for the first cultivation and at weekly intervals until the plants are too large. It must be used frequently, as it will not eradicate large weeds. Cultivation in general should be frequent and shallow. Cultivate deep only when the cotton is growing too fast and it is desired to stimulate fruiting. Economize labor by using cultivators rather than sweeps. Work the land as soon as dry enough after each rain, aiming to preserve a shallow dust mulch to conserve moisture. Never plow or cultivate when the land is wet. Lay by the cotton only when it is too large to cultivate without injury.

SEED SELECTION.

The high quality of Sea Island cotton to-day is due to the careful seed selection that has long been practiced on the Carolina Sea Islands. Seed selection is therefore a feature of prime importance, the keystone of the arch. To realize its influence on the industry one must trace its history from the beginning.

ORIGIN OF SEA ISLAND COTTON.

As indicated by its botanical name, *Gossypium barbadense*, the original home of the plant is thought to have been the West Indies. When first introduced into the mainland of America, about 1786, it is reported to have been considerably different from the present form. The plant was a perennial—larger, later, and less productive than now. The method of culture described on page 23 was adopted to reduce the size of the plant and stimulate fruitfulness, but the great change that has been wrought is due mainly to careful breeding. Through several generations the planters have selected seed from the earliest, most compact, and most productive plants, with the longest and finest staple, until the character of the plant has been radically changed.

CONTINUED BREEDING NECESSARY.

The cotton plant has become variable, enabling the breeder to select finer forms and to raise the standard of the crop far above its natural level. By reason of this variability, seed selection must be continued to prevent deterioration, for there is no standing still. The upward movement must be continued by perpetuating the finer types desired by the cultivator, or, if neglected, the inferior plants will increase rapidly in the crop and the cotton will tend to revert to its original type.

Sea Island Methods.

There has been developed on the Sea Islands a well-defined and uniform system of selection. It is based on the correct idea—that of discovering the best individual plant and preserving its offspring. A number of superior plants are marked and carefully compared in the field, then picked separately and the seed cotton critically examined. The best plant is retained and the seeds planted in a plot by themselves, one or two in a hill, making perhaps 500 plants in all. If this plot retains the good qualities of the parent plant the cotton is picked and the seed again planted separately, making a 5-acre plot the third year. The fourth year there will be seed enough to plant the whole crop, all descended from the single stalk first chosen. A new individual plant is selected every year, so that a fresh supply of seed is always being grown. Seed from the general crop is considered less desirable for planting at home and was formerly sold to Georgia or Florida growers.

Sea Island Varieties.

A number of planters on the Sea Islands have been practicing this system of seed selection for many years. Each man has his own ideals respecting the best form of plant and the most profitable length of staple and selects a type conforming most closely to this ideal. There have thus been developed a number of distinct varieties of Sea Island cotton, which differ in length and quality of staple, form of plant, size and appearance of seed, percentage of lint, and other features. They are not given varietal names as much as in the case of other cultivated crops, but when offered for sale are known by the name of the breeder, as Hinson, Seabrook, Rivers, La Roche, etc. These names have not been preserved when seed has been sold to interior points and there is consequently much confusion in the matter of varietal names.

Varieties of Sea Island cotton are constantly changing. Each breeder renews his stock annually and in doing so may propagate from a plant differing from his old type, in which case his entire crop four years hence would be influenced.

Breeders' rights.—Many of the Sea Island varieties, particularly the finer ones, are considered the personal property of the originator, who will not part with any of his seed, even to his neighbors. To would be likely to result in an overproduction of that particular le and a lowering of prices, as the market demand for the higher-ed staples is exceedingly limited. Furthermore, the breeder is much entitled to reward for his labors as the inventor of a new chine is to patent rights. A strain of fine cotton is the product of any years of careful selection and could not be duplicated without ng-continued work requiring much skill and care.

Sale of seed from the Sea Islands.—On the Sea Islands the growers of medium staples, for which there is a larger market than for the finer product, have for many years sold their seed, both at home and to buyers in Georgia, Florida, and foreign countries. In 1904, however, West Indian competition stimulated the formation of an association to prevent the sale of seed outside the Sea Islands, and at the present date this embargo is still in force. The right of these growers to dispose of their product as they see fit is not questioned. Their action, however, will have great influence on the interior sections, which have always depended on Sea Island seed. Georgia and Florida produce eight-ninths of the American crop, but because of total neglect of seed selection deterioration has been rapid there, requiring renewal of seed every few years.

Seed Selection will Succeed in the Interior.

Thrown on their own resources, the interior growers will find that they can grow their own seed and maintain a satisfactory quality. The success of the Carolina planters is due to their methods more than to their soil and climate. There are already men in Georgia and Florida who have maintained the quality of their cotton for fifteen years or more by selection without renewal from the Sea Islands. In fact, it should be possible to produce a variety better fitted for interior conditions than any imported seed, for adaptation to climate and soil can be secured together with greater productiveness.

METHODS OF SELECTION.

The amount of gain from seed selection will depend mainly on the method employed; the more care taken, the better will be the results. If any farmer is so situated that he can not select his own seed, let him at least obtain seed for planting from the middle picking in a field of known good quality, or purchase from some near-by seed breeder. He should not risk an entire season's labor by planting seeds of unknown value taken at random from a public gin.

Three methods of selection will be described. Under varying circumstances all of them may well be employed.

Roguing.

The simplest method of selection is called "roguing," because it involves merely the removal of inferior or varying plants, called "rogues" by seedsmen. This practice will serve to lessen deterioration in a variety already of satisfactory quality, but will not effect a very rapid improvement. Every grower of Sea Island cotton should destroy all hybrid and "run-out" stalks whenever observed. The hybrid plants are the results of crossing between Sea Island and Upland varieties, or between Sea Island and other hybrids. They are the tall stalks, often called "male stalks" or "bull cotton," which are quite common in the average interior field. They do harm in three ways: (1) On account of their great size and vigor, one of them takes up as much room in the field as two good plants; (2) they bear a scanty crop which is so inferior that it reduces the price of the whole crop when detected in the sample; and (3) every seed from one of these plants produces a hybrid plant the following year.

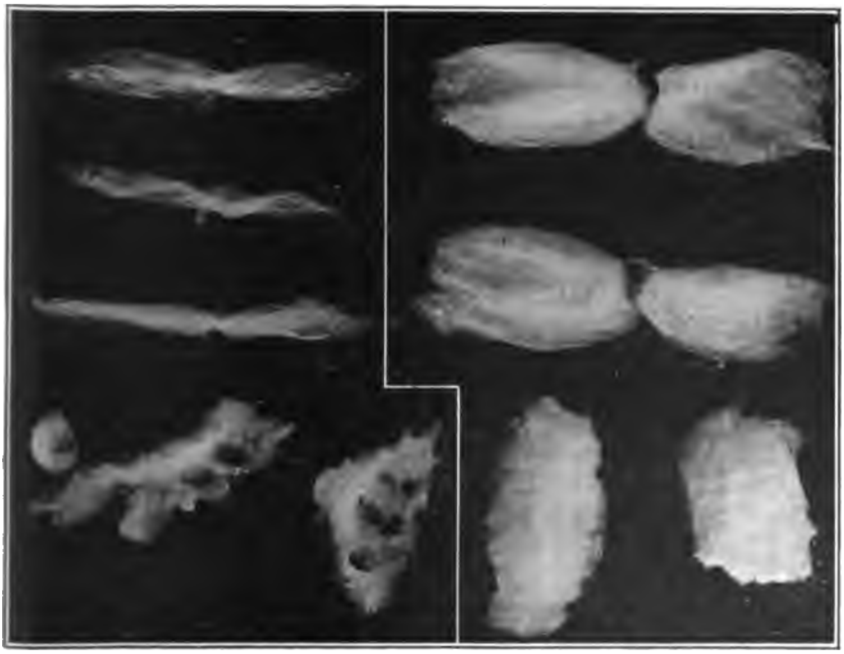

FIG. 6.—Good seed cotton at the right compared with a "run-out" form at the left. The lower figures are the locks as picked. The upper figures are seeds with the fibers straightened out.

"Run-out" plants are pure Sea Island stalks which have deteriorated until the staple is short and too scanty to cover the seed. (Fig. 6.) They can not be detected until the bolls begin to open, when it is best to pull them out, as the crop they will bear has no value and only lowers the quality of the rest of the crop.

General Selection.

A simple method of improving seed is to pick from the best plants in the field enough to plant the next crop, or to select with still more care a smaller quantity to plant a seed plat of 3 or 4 acres to grow seed for the general planting the following year. The selection of the seed is best done by the farmer himself, assisted by two careful pickers. Select from the middle picking before the main crop is gathered. Search through the whole field for the best and most productive plants. Before directing the pickers to pick a plant, examine the staple and reject every plant with lint less than 1⅝ inches long. It would be a vital error to select without regard for length of staple, because plants with wide-opening bolls would then be chosen and this quality is often accompanied by a short staple. Gin this selected cotton separately on a clean gin.

This method of selection can easily be followed by every farmer and will produce good results, though not equal to the next plan described.

Pedigree Breeding.

Pedigree breeding, while requiring more careful attention than the methods already described, will effect the greatest improvement in the least time and should be followed by all who undertake the production of improved seed for sale. It is substantially the same as the plan followed by the planters on the Carolina Sea Islands, where no other method would maintain such a high quality. All progressive farmers would profit by adopting this system.

The fundamental principle is to breed from a single plant of exceptional merit, which must also prove its ability to transmit its good qualities through its seed to its progeny. Instead of planting mixed seed taken from a large number of good plants, as in the preceding method, the choice is narrowed first to a few plants, which are compared not only as to productiveness, length and quality of staple, etc., but also with regard to their prepotency and the uniformity of their offspring, as determined by a planting test the following year, until finally the progeny of the best individual is chosen. The seed thus obtained is increased as rapidly as possible until enough is secured to plant the whole crop.

A similar method is practiced by successful breeders of other crops, as, for example, in the "ear-row" plan of improving corn now so generally followed in this country. Plant breeders agree that too much stress can not be laid on the importance of searching for the exceptional individuals that may have great potential value for crop improvement. The best varieties of all our cultivated crops whose history is known came originally from a single plant or tree of unusual merit discovered by some observing grower.

Beginning the selection.—It is assumed that the farmer who desires to improve his cotton has already planted a field from the best obtainable seed and has pulled out all objectionable hybrid or "run-out" stalks. He should begin to make selections as soon as the first bolls open. Choose the plants having a long staple and in other respects conforming to the ideals described. Mark these plants with a white cloth and a tag bearing a number. It is advisable also to set a tall stake by each selected plant so that it can be found more readily. Pick each separately and at the end of the season spread on a table and compare the various lots critically and at leisure with regard both for length and fineness of staple and for yield. Discard the inferior ones until from ten to twenty-five are left. These are to be further tested by planting the second year to discover the prepotency or transmitting power of each.

Second year: The progeny test.—Plant the seeds from the selected plants in adjoining rows, keeping each lot separate. These small lots can be planted in the lint, provided care is taken not to cover them very deep. Select ground adapted to cotton and have it well prepared. Plant with care, dropping only two seeds to the hill. If possible, have 100 hills to the row. The location should be as far from other cotton as possible to lessen the crossing. Isolation can usually be secured by planting the seed plat in the section of the farm used that year for other crops—in the middle of a cornfield, for instance. If it is necessary to plant near other cotton, plant a wide border of the same variety around the breeding plot. By all means avoid proximity to Upland cotton, which is the most serious factor in the deterioration of inferior Sea Island cotton.

The object of this planting is to determine the relative merit of the different selections, and particularly their uniformity. The general excellence of the plants in each row should be considered—their vigor, productiveness, and freedom from disease. Any row lacking uniformity to a marked degree should be eliminated from consideration. When the bolls open, compare the staple, length, fineness, and uniformity, and finally choose the row possessing the greatest merit. This is to be the beginning of the new strain. In this row mark and pick separately the best ten plants. (Fig. 7.) Pick together the remaining plants in the row. The other rows in the plat, although not retained for breeding, ought to be better than unselected seed and may be used for planting the general crop.

The desirability of this method of breeding will not be appreciated until it has been tried and the variations in the offspring of different plants observed. It is common to find one row with plants all alike possessing a staple longer than the average and also more productive, while another row may be widely variable in form of plant and quality of staple. Plants of superior merit often appear in the variable rows. They should not be saved, however, as the chances are that their offspring will be variable like the row in which they appear,

Third year: The increase plat.—The seed from the best row of the second year is to be planted in a small field to produce seed for planting the general crop. Any inferior plants that chance to appear in this field should be destroyed, but no other selection need be practiced, as it is not intended to plant this strain permanently, but to renew the seed annually from a new increase plat.

In addition to the increase plat, the progeny test is to be repeated, using the ten plants chosen from the best row and any others of exceptional merit that may be discovered in the general field. Select in the same manner as before the best row and the best plants therein.

Fourth year: The general crop.—In this year and each succeeding year the same process of selection is carried out. This should become a part of the regular farm practice, to be considered of equal importance with cultivating and fertilizing. The several stages under way from now on are as follows:

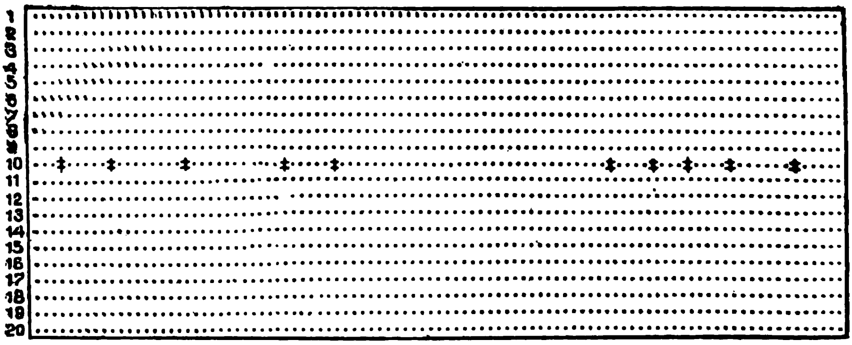

FIG. 7.—Diagram of a pedigree breeding plat. Row No. 10 has been selected and 10 plants in it marked to be saved separately.

(1) Selection of the finest plants.
(2) Progeny test to determine uniformity and productiveness.
(3) Increase plat.
(4) General crop.

If seed from the general crop is to be sold, careful attention must be paid to removing tall hybrid or "run-out" stalks from the field whenever they are observed. Seed from the last picking had better be rejected, as the upper bolls do not mature their seed as well as the lower ones.

Separate ginning of the seed crop important.—Cotton from the breeding plats or from other fields intended for seed should be ginned separately and the gin and conveyors first thoroughly cleaned of foreign seed. The farmer should personally superintend the ginning of his selected seed, as a mistake at this stage might lose him the fruits of several years' work. Owners of ginneries should realize their opportunities and obligations in this direction and afford their patrons every facility for the separate ginning of selected seed cotton

The sale of cotton in the seed is a hindrance to seed improvement, unless there is at the same time an organized movement for the distribution or sale of improved seed to the farmers.

Improvement of Cotton Seed by Gravity Separation.

It has been found possible to secure a marked gain in the percentage of germination and the vigor and productiveness of the cotton crop by removing the light weight and imperfect seed before planting. For example, in an experiment by the writer the heavy seed germinated 27 per cent better than unselected seed and 42 per cent better than light seed thrown out by the air blast.

The separation is effected by means of an air blast produced by a fanning mill modified for the purpose. All who handle considerable quantities of Sea Island cotton seed will find it profitable to use such an apparatus. Seed from which the unginned locks and tufted seeds have thus been removed is much better adapted for use in cotton planters. Another very important gain in this process is the removal of the fuzzy seeds of Upland hybrids, which on account of their greater surface area are blown out with the light seed. Persons interested in the matter should write to the Secretary of Agriculture for Farmers' Bulletin No. 285, entitled "The Advantage of Planting Heavy Cotton Seed," by Webber and Boykin, which describes the method and apparatus fully. All ginneries should be equipped to treat in this way seed intended for planting.

IDEAL QUALITIES OF SEA ISLAND COTTON.

Length of Staple.

In Georgia and Florida the breeder should work for a staple not less than 1⅝ inches or more than 1¾ inches in length. In South Carolina each planter is guided by his own preferences, some planters choosing the medium kinds on account of their greater productiveness and others finding it profitable to grow the extra fine and long varieties. Experience has shown, however, that these fine strains, having a staple 2 inches to 2½ inches long and selling from the Sea Islands at 40 to 60 cents per pound, are not profitable in the interior. As compared with the medium sorts, they are less productive and more subject to disease, while the bolls are smaller and the cotton harder to pick. The fine staple requires more care in handling than the interior farmers are accustomed to give, and the interior markets will not pay as high prices as Charleston. In the past the best results in the interior have been obtained with strains classed on the Sea Islands as medium fine, such as Hinson and Seabrook.

To determine the length of staple from a sample of seed cotton, pull a lock apart and take a single seed and carefully straighten out the fibers with the fingers or a fine comb. Measure the length of the greatest number of fibers; then test several other seeds from the same plant.

Uniformity of Staple.

After determining the length, estimate the amount of shorter staple in the sample and discard plants having a portion of their staple either very long or too short. Uniformity is an important quality, as the spinner can not utilize the short fibers, which are combed out as waste.

Strength of Staple.

Pull a tuft of fibers until it breaks. Diseased plants show a marked weakness, and some healthy ones produce a weak staple and should be discarded.

Percentage of Lint to Seed.

This quality, or the "ginning average," is important, but farmers often lay too much emphasis on it, forgetting that it is the total yield of lint per acre that determines their profit.

The percentage of lint should be determined by ginning and weighing both lint and seed. The result is usually expressed in terms of the amount of seed cotton required to produce one pound of lint. To determine this, divide the weight of seed cotton by the weight of lint. To express the same in per cent, divide the weight of lint by the weight of seed cotton. Having the ginning rate, to reduce it to a percentage basis, divide 1 by it; for example, 3.33=30 per cent. The per cent of lint varies considerably in different varieties of cotton, from 25 per cent, or 1 to 4, in extra fine Sea Island cottons to 39 per cent, or 1 to 2.56, in small-seeded Upland cotton. It varies among plants in the same field, and there is a marked variation in different seasons, the per cent of lint being higher in favorable seasons. Even with the same variety and the same season, differences in soil and culture influence the per cent of lint. For example, a consignment of Seabrook seed was divided among several farmers in 1904 by the A. P. Brantley Company of Blackshear, Ga. The ginning rates of the different crops produced from this seed varied from 3.96, or 25 per cent, to 3.10, or 32 per cent, the average of 41 fields being 3.42, or 29 per cent.

Color of Staple.

The staple should have a lustrous creamy tint in preference to a dead white. The color should be uniform, as mixtures of white and creamy cotton are not desired by the buyers.

Fineness.

Fineness depends on the diameter of the fibers, which can be measured exactly only with a microscope. An excellent opinion can be formed from the feeling of the cotton, if not too dry. Fineness is a very important quality to the spinner.

Productiveness.

Next to length of staple, productiveness is the most important quality. In making selections a preliminary estimate can be made by the eye or by counting the bolls. Sea Island planters estimate that every 15 bolls per plant equals 100 pounds of lint per acre under ordinary conditions. In breeding, the principal weight should be placed upon the yield from the progeny rows the second year of the selection. Strains derived from different plants in the same field have been found to vary greatly in productiveness, and careful selection will greatly improve any variety in this respect.

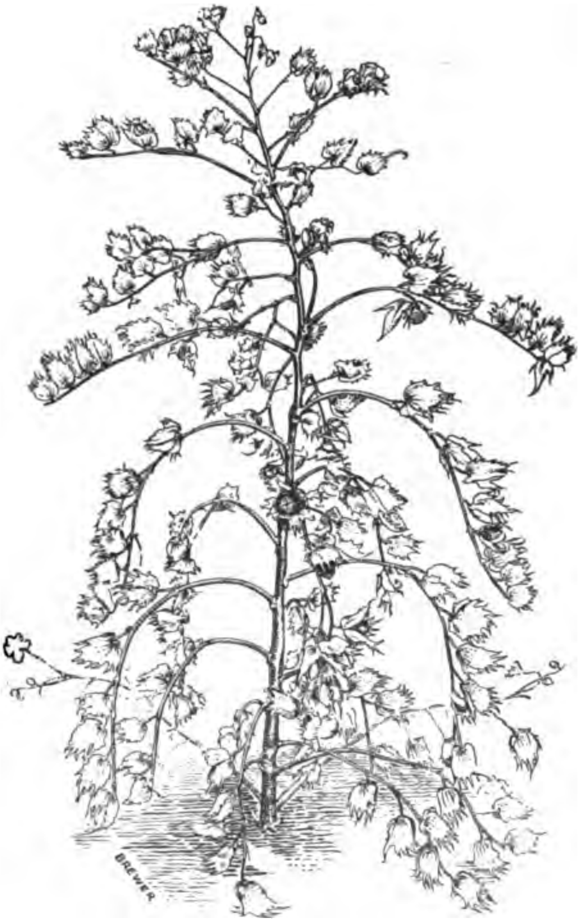

FIG. 8.—Ideal form of cotton plant. The leaves have been removed to show manner of branching.

Form and Size of Plant.

The plant should be compact, 4 to 6 feet high, with a strong central stalk and 2 to 4 well-fruited basal branches. Fruiting branches should occur at close intervals, 1 to 2 inches, and a habit of double bearing or producing an axillary branch at each node should be developed. All branches should be close jointed and bear a boll at every joint. (See fig. 8.)

Bolls.

The bolls should be large, long, and well filled to the end, not tapering too abruptly. As a rule a long boll indicates a long staple and a short or obtuse boll a shorter staple. The number of locks should be four. The majority of Sea Island bolls have but three. More than four locks, even if obtainable, would not add to the yield or to the convenience of picking. The bolls should open well, as such bolls ripen their cotton better and are far easier to pick. In making selections do not choose wide-opening bolls without examining the staple, as a wide-opening boll is usually correlated with short staple. If the size of the involucre, or "square," could be reduced by breeding, there would be less trouble from bits of dry leaf in the cotton at picking time.

Seed.

The seed should be small, but well filled, black, with a small green tuft at the end. A large, perfectly bare seed is correlated with a low ginning rate and a large, coarse plant, and is usually taken as an indication that the strain is running out. An excess of short fuzz is characteristic of some Sea Island varieties, but such cotton can not be ginned as rapidly as other kinds. Large seeds entirely covered with white or green fuzz indicate hybridization with Upland cotton, but occasionally occur in pure Sea Island cotton.

Earliness.

Very early varieties are usually less productive than later ones, while very late ones may be caught by frost before fully mature. A medium season of maturity is to be preferred.

Disease Resistance.

In some instances disease resistance may be a feature of fundamental importance, as when the land is infected with wilt. In such cases one of the disease-resistant varieties described on page 46 should be planted. In all selections attention should be paid to this point, particularly to secure resistance to black-arm and to anthracnose of the bolls.

HANDLING THE CROP.

PRESERVING THE FULL VALUE OF THE CROP.

After devoting his best energies for a whole season to the production of a fine crop of cotton, the farmer must still continue his vigilant oversight until the staple has left his hands. Sea Island cotton is a fine and delicate product and there are many ways in which it may be injured and its value reduced. All defects in the cotton are ultimately charged to the farmer's account and reduce the price paid to him. If the spinner finds in a lot of Sea Island cotton 10 per cent more waste than in Egyptian cotton available for the same purpose, he will manifestly be unable to pay as much by 10 per cent for the Sea Island. By a little care much of the present waste can be avoided; hence strict attention should be paid to these factors.

GRADE: DEFINITION AND IMPORTANCE.

In the cotton market the term "staple" refers to the length and fineness of the fiber, and these points are influenced most by seed selection.

The term "grade," on the other hand, indicates the appearance of the cotton as regards cleanliness and color, qualities influenced mainly by the manner in which the cotton has been handled. The price is considerably influenced by the grade.

Defects Influencing Grade.

(1) **Loss of bloom or luster.**—The best Sea Island staple has a gloss or luster which adds greatly to its beauty and is indispensable for certain kinds of fabrics. This bloom is destroyed by exposure to sun and storm when cotton is left long unpicked, and the staple then has a gray, lifeless appearance, sometimes termed "mildewed" or "weather-beaten." A similar effect is produced by picking cotton when wet with rain or dew and storing it in piles without first drying it in the sun.

To preserve the staple at its best, pick often—once a week, if possible—and expose the seed cotton to the sun to dry. This is done by spreading it in a shallow layer on a low roof or arbor, where it is turned frequently until so dry that the seed will crack between the teeth.

(2) **Loss of strength.**—The loss of luster is accompanied by a lessened strength, so that a staple originally good fails to make as strong thread as before—an added reason for better care. Very dry cotton is also not as strong as that which, under proper treatment, has retained its natural moisture.

(3) **Nep.**—Spinners designate as "nep" small white specks in the baled cotton, which they find very difficult to remove in spinning and which often go into the thread and appear in the completed fabric as white dots. These neps are in reality tangles in the fibers, which when viewed under a microscope are seen to be weak and undeveloped. They are due in part to picking cotton before maturity; a boll that is forced open to extract the lint is a source of nep, as the cotton in it does not get the necessary exposure to the sun to dry and straighten and strengthen the fiber. Other nep originates with weak cotton from diseased bolls or from any other cause that prevents the fibers from attaining full development. Such undeveloped staple comes from the gin full of nep. Poor ginning, however, by weakening and breaking

fibers increases loss from this cause. Pickers should be cautioned against picking unripe bolls. Thorough sunning will in part remedy the trouble, and good culture, by producing healthy plants, will do more.

(4) **Broken leaf, etc.**—The presence of fragments of leaf, weed seeds, and other foreign matter in the cotton reduces its grade. These are often difficult to avoid, particularly after storms, when bits of the dried square, or involucre, are often mingled with the cotton; but pickers should be watched and cautioned against picking dirty cotton. Fortunately, the spinners find it easier to remove this class of impurities than the nep previously mentioned.

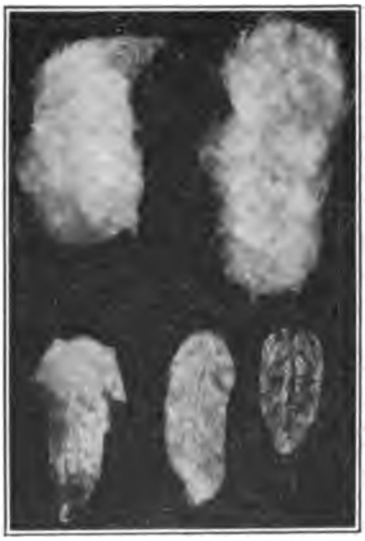

FIG. 9.—Locks of Sea Island cotton from healthy bolls (at the top) compared with hard locks from diseased bolls (underneath).

(5) **Short fibers.**—A large part of the waste is due to short fibers, which have to be combed out. They originate in part in variations in the length of the staple on the seed, a serious fault, to be remedied by seed selection as discussed under uniformity (page 34.) Short fibers are in other cases due to imperfect ginning, which breaks or crimps the staple and may be avoided by better management.

(6) **Weak fibers.**—The greater part of the waste is due to the presence in the baled cotton of staple from undeveloped or diseased bolls. The bolls in such cases do not open and the fibers do not expand but remain matted together in a "hard lock" (fig. 9). All locks that do not open out after drying may be assumed to be worthless on account of weak and undeveloped staple. Pickers should be instructed not to gather hard locks, and in the assorting after picking all remaining ones should be thrown out. Seed cotton still containing hard locks when it reaches the gin can be improved by setting the stripper bars well back from the roller to allow the locks to fall through. Close ginning is a mistake, for it costs the farmer more through deterioration of his cotton than he gains by the slight increase in weight.

The number of hard locks can be greatly reduced by bringing the cotton to perfect maturity through attention to fertilization and culture and to the control of diseases.

(7) **Lack of uniformity in the bale.**—Separate late from early pickings. Buyers desire to have each bale uniform within itself. If, therefore, a late picking is inferior to an earlier one, it should not

be ginned and packed with it, as the price of a bale is determined by the poorest cotton found in it after thorough sampling.

(8) **Yellow cotton.**—Buyers invariably complain when a sample of cotton contains yellow staple, and the grade and price are consequently reduced. Yellow tufts in the ginned cotton come from discolored locks that should have been left unpicked or been sorted out before ginning. They originate, as a rule, in bolls attacked by the anthracnose or bacterial boll-rot (see page 47). Their presence in a bale is an indication of too close ginning.

(9) **Sand.**—A bale of cotton always contains considerable sand which has been blown into the open bolls. This is quite unavoidable, but when cotton has been left unpicked and has blown out on the ground the quantity of dirt is increased.

(10) **Moisture.**—An element of waste from the spinner's standpoint is the moisture which evaporates during the process of manufacture. This moisture may be excessive in cotton picked early in the season and ginned without drying. There may, on the other hand, be a lack of moisture. The cotton may be overdry and appear harsh and brittle. Such cotton gives trouble in spinning, because of the electric current it develops.

The question of moisture is one of the most important connected with the handling of cotton. Either an excess of moisture or a lack of it reduces the grade. The farmer, however, must never add water to the cotton, but he should seek to retain the optimum amount of natural moisture. This means that to drive off excessive moisture freshly picked cotton should be sunned until the seeds will crack in the teeth. The staple will then be slightly overdry and unfit to gin or offer to the buyer. To restore its grade it should be "bulked." Bulking, as practiced on the Sea Islands, is placing the seed cotton, after sunning, in a large, deep, square pile in a cool room. It should be packed down solidly and, if the air is dry, covered with blankets or boards and left from three to six weeks before ginning. When it comes out of bulk the staple has lost its harsh feeling and is soft, oily, and glossy.

Care must be taken never to bulk cotton that has not previously been well dried, or the pile will heat. On the other hand, a loose, conical pile, formed by throwing seed cotton into a storeroom, is not a bulk, for it does not prevent the cotton from drying out still more. As a rule, cotton brought to the gins early in the season is too green and damp and needs sunning to put it into good condition, while that coming in late or taken from the storehouses during the winter is overdry and consequently harsh and brittle. Both the lint cotton and the thread spun from it lack their full strength if too dry. Everyone knows how a dry twig will snap in the fingers, while a green one only bends. The same to a less degree is true of the cotton fiber. The quality is best maintained, however, by avoiding overdrying rather than by the addition of moisture.

(11) **Injury in ginning.**—The grade of cotton is often reduced during the process of ginning. This may be the fault of the farmer, as when he brings his cotton to the gin damp or full of hard or yellow locks or broken leaf and insists on close ginning; or the fault may lie with the ginner, who has failed to adjust his machines so that no seed can be broken. Briefly stated, seed cotton must be dry; if green or wet, "crimping" invariably results, to the serious injury of the fiber. The seed cotton should be free from hard locks or else the stripper bar should be adjusted to let them fall through with the seed. Close ginning is a form of adulteration instantly detected by the buyer and very costly to the farmer. The modern fruit grower has learned that he can not profitably mix his culls with his first-grade fruit, and the cotton grower must come to a similar conclusion.

The most frequent defects due to ginning are the presence of portions of broken seed and the cutting or crimping of the fiber. Since poor ginning costs the farmer, at a conservative estimate, 1 cent a pound, the ginner should be required to maintain his gin in perfect adjustment and to gin the cotton free from cracked, clipped, mashed, or whole seed and free from crimp.

The ginned cotton should come from the roller steadily and in an unbroken flake. Whenever it does not do this, an examination will show that the adjustment is not perfect, and the cotton is liable to sustain injury unless the trouble is corrected.

SUMMARY.

The best practice in handling the crop may be briefly stated by describing the method followed on the Sea Islands, which should be adopted in the interior in so far as the labor conditions will permit.

Picking is done whenever enough cotton is open, about every ten days. The cotton is gathered as free from trash as possible and carried to the storehouse, where the next morning each picker sorts his own picking. The cotton is then spread on arbors to dry in the sun. It is watched and turned frequently, and usually dries in one day. After sunning, the seed cotton is assorted by women, who remove any yellow locks, bits of leaf, etc. If very dirty it is whipped over a coarse wire screen stretched across a small box to take out the sand. Very fine cotton is again sorted or overhauled by another set of laborers. The cotton is then bulked and allowed to remain from four to six weeks before ginning. During the ginning, one or two hands inspect the cotton as it passes to the gins, to remove impurities, and one or two others "mote" the lint as it passes from the gin to the press, by picking out yellow tufts, etc. By all these means a high grade is maintained for Sea Island cotton, which is reflected in a price per pound several cents higher than that paid for interior cotton.

DISEASES OF SEA ISLAND COTTON.

SORE-SHIN AND DAMPING-OFF.

Cotton seedlings sometimes become diseased shortly after coming up, particularly when soil or weather conditions are unfavorable. The term "sore-shin" is applicable to diseased spots or cankers formed on the stem or root of the seedling. These spots result in a cessation of growth, in yellow leaves, and, if they encircle the stem, in death.

A fungus (Rhizoctonia) is usually held responsible for the trouble, but it is only after cold and wet weather has checked growth and weakened the plants that serious loss results. If warm and favorable weather prevails the cotton soon outgrows the disease. No direct remedial measures are practicable. Danger of loss can be minimized by thorough preparation of the land before planting, by draining lower lying fields, and by thick seeding. Broken stands must be filled by replanting.

Damping-off, or the collapse of the stem at the surface of the ground, may be due to the sore-shin fungus or to other parasites. It is often caused by anthracnose, in which case the seed was probably infected before planting. The recommendations for the treatment of anthracnose on page 47 apply also to this form of it.

BACTERIAL BLIGHT.

There is a bacterial disease of cotton (*Bacterium malvacearum* Erw. Sm.) which is found to occur on different parts of the plant, producing various symptoms and receiving various names, such as angular leaf-spot, black-arm, boll-spot, etc., according to the point of attack. We describe all these together.

The earliest appearance of the disease is perhaps on the leaves, where it produces what is commonly known as the angular leaf-spot. These spots are at first a water-soaked green, becoming black when older. They are angular in outline, one-eighth to one-fourth inch in diameter. They are scattered over the leaf, but are often more numerous near the large veins. When one of these veins is attacked the disease rapidly extends its whole length.

Infection of the petiole is less common, but sometimes occurs, causing the leaf to turn yellow and fall off.

Infection of the pedicel of the bolls is a common cause of shedding and of failure to open. The bolls themselves are also attacked, the points of infection being water soaked at first and then growing darker. This organism does not appear to be as active a cause of boll-rot as the anthracnose fungus and several bacteria which appear to follow it and which very likely gain entrance through the bacterial spot.

Young plants in June are sometimes attacked on the main stem, near the ground or higher up, where a canker is formed which so weakens the stem that it is broken off later by winds or during cultivation. It is later in the summer that most damage occurs, when the disease attacks the fruit-bearing limbs. The spots on the limbs are dark—nearly black—and, though not deep, so sap the vitality as to cause the shedding of all the smaller bolls. In many cases, when the season is wet, infection by anthracnose follows and adds to the injury. Several forms of the disease are illustrated in figure 10.

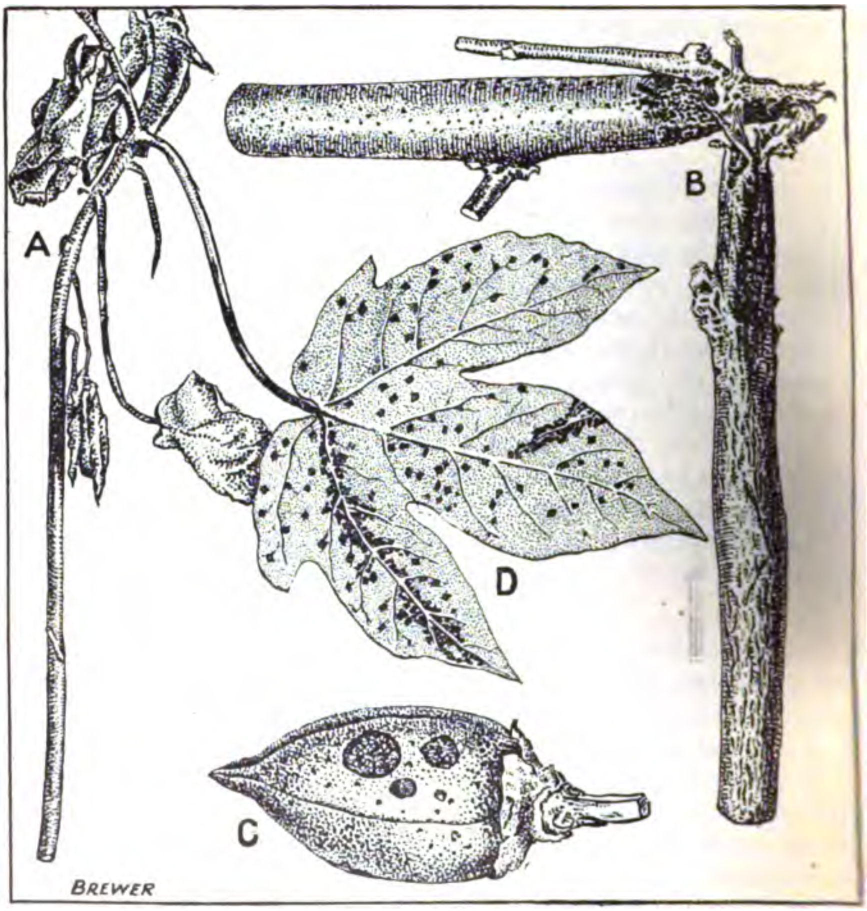

FIG. 10.—Diseased leaves, boll, and stems of cotton plant showing several forms of bacterial blight.

Egyptian cotton is peculiarly subject to this trouble—so much so that its cultivation in the Southeastern States appears to be impracticable. There is considerable variation in the resistance of different races of Sea Island cotton, Rivers, for instance, being rather susceptible, while Centerville is nearly immune.

Remedial measures must be indirect. Resistant varieties can be developed by selection. Diversification and rotation of crops will tend to reduce the amount of infectious material remaining on the land and will lessen the disease. Black-arm is probably carried through seed to some extent, and the selection of seed from healthy bolls only will greatly aid in its control. It may be expected that a reduction of the nitrogen and an increase in the amount of potash in the fertilizer, by inducing development of less succulent branches, will reduce the danger of infection

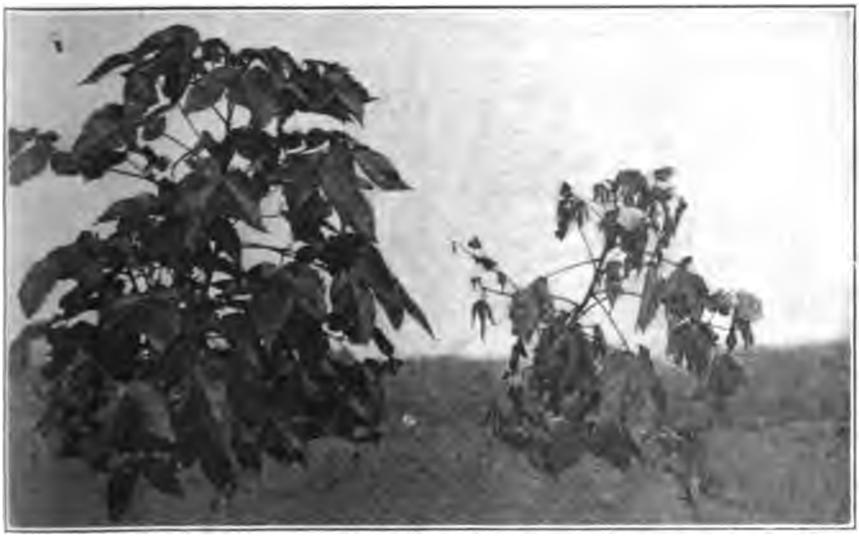

FIG. 11.—A plant recently affected with cotton wilt (on the right), with a healthy resistant plant growing beside it.

WILT.

Cotton wilt, often called black-root, is one of the most serious diseases of the crop wherever it occurs. It is characterized by the death of the plants in gradually enlarging spots in the field, where the disease reappears year after year. The plants are attacked at any time after they are a month old, but die fastest in June and July. The affected plants wilt, or a few leaves at a time turn yellow between the veins and fall off. (Fig. 11.) When the stem or root is cut the woody portion is found to be brown or black. The discoloration is one of the most characteristic symptoms of the disease and has given it the name black-root.

Wilt is most prevalent on the sandy or sandy loam soils best suited for Sea Island cotton. Low spots and rich bottom lands often escape the disease long after the cotton on the higher portions of the field is killed. Clay soils are, as a rule, free from it, though some cases are reported. Geographically wilt occurs more or less in all the Sea Island cotton-growing districts, both in South Carolina and in the interior. It is also serious in Upland cotton fields from North Carolina to Louisiana.

Cause.

Wilt is due to a fungus (*Neocosmospora vasinfecta* [Atk.] Erw. Sm.) which enters the small roots from the soil, grows into the water-carrying vessels of the root and stem, and fills them, thus shutting off the water supply of the plant.

This fungus spreads by direct growth through the soil and also forms four kinds of spores, viz, one in the interior of the stem, another in cushions on the outside of dead plants, a third in the soil or on the surface of the plant, while the fourth or perfect spore stage is produced in minute bright-red sacs (perithecia) borne under ground on the bark of the dead roots. This fungus is without doubt spread to some extent by the feet of stock passing through the fields, carried in drainage water from high to low land, and distributed by plows and cultivators. When it appears in a field, attempts to restrict its spread are useless, so far as the writer's knowledge goes. As wilt attacks only cotton and okra, good yields of corn and other crops can be obtained on infected land. A long period of rotation tends to diminish the amount of disease, but the fungus can live in the soil for several years, cases being on record where seven years' rest failed to free the land from wilt.

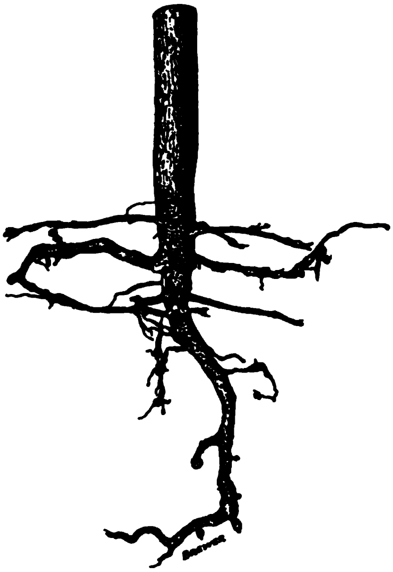

FIG. 12.—Roots of a cotton plant affected with root-knot.

An important point in connection with the question of rotation is the danger from root-knot, another disease, described on page 46, which often occurs along with the wilt.

Enlargements of the roots of cotton (fig. 12) indicate that root-knot is present and that a rotation of crops must be practiced to control it. The combined treatment of wilt and root-knot is based on the following principles:

(1) Cotton wilt attacks only cotton and okra. It does not disappear after rest or rotation. Resistant varieties can be secured.

(2) Root-knot attacks cotton, cowpeas, sweet potatoes, vetch, and

ons, and many other crops, but does not attack corn, oats, velvet beans, or the common grasses. It diminishes and finally disappears when all susceptible plants are kept off the field, and in ordinary farm practice can be held in check by a suitable rotation of crops. No variety of cotton is wholly resistant to root-knot.

A rotation similar to the following should therefore be adopted: First year, corn with Iron cowpeas or peanuts; second year, winter oats, or, if preferred, rye or wheat cut early for hay and followed at once with velvet beans; third year, cotton of a wilt-resistant variety.

Soil Treatment not a Successful Remedy.

It has been found impossible to kill out the fungus in the soil by any treatment with fungicides. Experiments have been made with lime, sulphur, copper sulphate, formalin, carbolic acid, and numerous other substances, none of which had any effect in reducing the amount of wilt.

The fungus is so spread through the soil that it is unlikely that it can ever be killed by any treatment that would be cheap enough to be practicable.

The Relation of Soil Conditions to Wilt.

It should be emphasized that wilt is due to the presence of a parasitic fungus, not to any unfavorable soil conditions. The fungus is, therefore, to be looked on as a weed and the disease may be expected to appear wherever its spores are carried. There are no chemical or physical differences between wilt-infected and healthy soils of the same type. Wilt is not due to the continual use of commercial fertilizers nor to the exhaustion of any element of plant food. Its preference for light and sandy soils has already been noted. Our experiments indicate that the free use of stable manure will assist in the control of wilt by increasing the vigor of resistant varieties, but the ordinary nonresistant kinds are not sufficiently protected by stable manure. In the same way other organic fertilizers, like compost and leguminous crops plowed under, will effect an improvement of the crop.

Control through the Use of Resistant Varieties.

It has been found possible to secure by seed selection varieties of Sea Island cotton resistant to wilt which will yield full crops of good quality on badly infected land, provided there is not too much root-knot present also. They were developed on the Sea Islands by selecting seed from exceptional plants that withstood the disease and remained healthy in the most infected spots. The first and best of these varieties is the Rivers, bred by Mr. E. L. Rivers, of James Island, S. C., in connection with the experiments of this Department. The Rivers cotton is productive, vigorous, compact, branching low, and with small, close-jointed limbs, often double bearing; bolls medium size, 3 to 4 locks; seed small, black, with a small green tuft; average per cent of lint to seed 28, giving a ginning rate of 3.57; staple fully to extra fine, and when grown on the Sea Islands 2 inches long. The Rivers cotton is an excellent variety for the Sea Islands and for the best localities in the interior, but has too low a ginning rate to be popular there, although its total yield per acre compares favorably with any other. It has also shown some susceptibility to black-arm when cultivated in Georgia.

A second variety, the Centerville, was selected with special reference to interior conditions. It differs from the Rivers in having smaller and more numerous bolls and a shorter staple—1⅝ inches—with a ginning rate of 3.30. The Centerville variety is noteworthy in being almost immune to black-arm. It is not fine enough, however, for the Sea Islands, and has defects when grown in the interior, especially in that its bolls are small and are often set in greater numbers than the plant can mature, resulting in a tendency to dry up toward the end of the season.

Other resistant strains have been developed, but as they are not at present obtainable for cultivation in the interior they are not described here.

Farmers who have wilt-infected land should secure seed of a resistant variety or, failing in this, should plant some other crop than cotton on the disease-infected field.

Once a wilt-resistant variety is obtained its quality should be maintained by the method of selection already described. Dependence can no longer be placed on the hope of obtaining seed from outside growers.

Control through Originating New Varieties.

Anyone who will give the necessary time and care can develop new resistant strains from the resistant plants that occasionally appear in fields of ordinary cotton. He must be prepared, however, to continue the breeding for several years before the desired results are attained.

No one should gather seed promiscuously from an infected field with the idea of gradually developing a resistant variety, for such methods are costly and usually fail. Breed from individual plants instead.

ROOT-KNOT.

Root-knot is a common and widely distributed disease in sandy soils throughout the southern tier of States. The effect on the plant is to lessen its vigor and dwarf its size. The seat of the trouble is at the root, which becomes distorted and covered with small swellings or knots. (See fig. 12.) These are produced by a minute nematode worm (*Heterodera radicicola* [Greef.] Mül.) which penetrates the roots and lives within them. On breaking open a large knot one can often detect minute pearl-like bodies, which are the female worms distended by masses of eggs.

Root-knot is a more serious enemy of peaches, vegetables, tobacco, and cowpeas than of cotton. It becomes of great importance to the cotton planter when it occurs in connection with wilt, which it very often does. The treatment required is the rotation of crops that has already been discussed under wilt.

ANTHRACNOSE.

The greater part of the loss from rotting of bolls is due to the disease known as anthracnose. This occurs as dark-colored spots on the bolls, which as they enlarge become depressed and gray or pink in the center. (See fig. 13.) The seed cotton in the bolls is discolored and spoiled. The cause is a parasitic fungus (*Colletotrichum gossypii* Swth.) which is very common throughout the cotton belt. While most of the injury is done to the bolls, the fungus can attack any other part of the plant. The disease is worse in wet seasons than in dry ones.

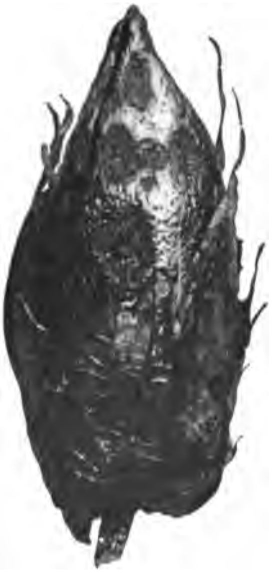
FIG. 13.—Cotton boll affected with anthracnose.

Remedies.

No direct remedy is practicable on account of the expense involved, but there are important preventive measures based on the fact that the disease is spread in part by seed from diseased plants. Where trouble from this disease is experienced, the seed for the next crop must be selected with care from perfectly healthy bolls. If a boll has one lock affected, there is danger that the fungus has penetrated all the seed. Avoid, if possible, running the selected seed cotton through a gin that has just been handling diseased cotton. All accessible parts of the machine should be wiped clean to prevent the fungus spores from remaining to infect the selected seeds.

Finally, when the crop is all picked, the old cotton stalks should be burned. Of these precautions the seed selection is the most important. It will not do as well to send away for seed from a healthy field, for the disease occurs everywhere.

RUST.

The disease commonly known as cotton rust is not primarily a fungous disease, but is caused by unfavorable soil conditions. Sea Island cotton fields affected by rust take on a reddish color, the leaves drop off, sometimes leaving the stalk bare, and the upper bolls fail to open. The cotton from such rusted plants is very weak and inferior. Rust is likely to develop in definite spots in a field, and unless a remedy is applied will appear year after year. Though other factors sometimes influence particular cases, there are three principal causes of rust in cotton, as follows:

(1) Exhaustion of the humus. Continued cultivation in cotton, by destroying the vegetable matter of the soil, is the most frequent cause of rust. The color of these old fields in midsummer is a lighter green, with a tinge of yellow, followed, when the bolls begin to mature, by the appearance of rust. A newly cleared field or an old fence row is, on the other hand, always green and free from rust. Stable manure is the most effective remedy in such cases, but a crop of velvet beans or cowpeas plowed under will effect a great improvement.

(2) Deficiency of potash. Most soils where cotton shows a tendency to rust lack potash, and an application of 200 pounds of kainit or 50 pounds of muriate of potash per acre will prove an effective remedy. Such soils are, as a rule, also deficient in humus, and a rotation of crops is usually advisable also.

(3) Lack of drainage. Rust often develops in low, wet places in a field where the higher portions are free from it, and for the same reason heavy and continued rains in August and September may lead to the development of rust in certain fields. Drainage by ditching or by tiles will be required in extreme cases. Most of these fields, however, become stagnant because the soil has no water-absorbing capacity on account of its lack of humus. If a leguminous crop were turned under every other year or stable manure applied liberally and the land plowed deep, the soil would soon be so changed in condition that heavy rains would not injure it and rust would disappear.

BLUE COTTON.

Blue cotton is a peculiar disease which occurs to a limited extent on the Sea Islands and in Florida. It is characterized by the deep green or bluish color of the leaves, the prostrate habit of the plant, which develops numerous lateral sprouts, and the shedding of the fruit. It is caused by some physiological or nutritional disturbance of the plant due to soil conditions not fully understood. The use of cotton seed and other organic manures aggravates the trouble. It has been successfully remedied on the Sea Islands by the use of salt mud, by liming, and by drainage.

INSECT ENEMIES OF SEA ISLAND COTTON.

The cotton caterpillar or leaf worm is the principal insect pest the Sea Island planter has to deal with, though slight injuries are sometimes inflicted by other insects. Readers are referred to Farmers' Bulletins Nos. 47 and 223 for full information relative to their control.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 303

Corn-Harvesting Machinery.

BY

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PREPARED UNDER THE SUPERVISION OF THE OFFICE OF EXPERIMENT STATIONS,
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., June 19, 1907.

Sir: The demand for the report on corn-harvesting machinery prepared by C. J. Zintheo and published as Bulletin 173 of this Office has been much greater than the somewhat limited edition of that bulletin would supply. For this reason it has been deemed advisable to condense the original report within the limits of a Farmers' Bulletin and so provide for a wider distribution of the more important information it contains. Such a condensed summary is transmitted herewith and recommended for publication as a Farmers' Bulletin of the Department.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

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CORN-HARVESTING MACHINERY.

INTRODUCTION.

Machinery for the care of the corn crop has been much more difficult to develop than any other line of farm implements. Although there has been considerable progress in methods of harvesting corn, the larger part of the crop is still husked by hand from the standing plant, only the ears being gathered, while the leaves and stalks are almost a total loss. This results in an enormous waste of valuable feed, for it has been demonstrated that when properly harvested corn fodder is as nutritious as good hay, and that the farmer who would receive the full value of his corn crop should secure this fodder with as much care as he gives his hay.

After the success of mowing and reaping machines, inventors tried to developed a corn harvester along the lines followed in the construction of those machines. Their success is not as yet complete, but the labor-saving devices so far perfected have largely changed conditions. The corn may now be cut, husked, and shredded with less labor than the cutting alone formerly required. At the same time all of the fodder is made available for feeding purposes.

CORN CUTTING WITH KNIVES.

A common method of harvesting corn is to cut the stalk close to the ground at a time when no damage is done to the ripening grain and while considerable of the saccharine juices still remain in the stalk.

The implement first used for corn cutting was the hoe, but as this was rather heavy and awkward the more progressive farmers substituted the corn knife. For a long time scythe blades were largely used in making corn knives, but these have now given way to all sizes and shapes of factory-made knives. The corn hook (fig. 1), which is now extensively used, is generally considered more convenient than the corn knife.

When the corn is cut it is customary to set it up in shocks to cure. Shocks vary greatly in size, ranging from 6 hills square (36 hills to the shock) to 16 hills square (256 hills); a very common size is 12 hills square (144 hills). Shocks of the smaller sizes are common in the North Atlantic States, where, according to the Connecticut Station, it is more difficult to preserve flint-corn stover; while 10 hills square and 12 hills square are common sizes in the North Central States. The common or four-saddle shock method consists in tying the tops of four hills together as they stand and then cutting and shocking the rest of the hills around these. Another method of making the shock is to use a wooden horse as a temporary support. In either case the shock is built around the support with great care to prevent it from being blown over by heavy winds or damaged by rain. In some cases the corn is tied into small bundles, which are set together to form the shock; more commonly the stalks are gathered as cut and set up an armful at a time. Where the wooden horse is used the shock is built about the horse by leaning the first bundles or armfuls against a pair of projecting arms formed by inserting a pole through a hole bored at right angles to the horse (fig. 2). When the shock has been set up the pole is withdrawn and the horse removed. When completed the shock is tied tightly near the top. A rope with a hook at one end is sometimes used to draw the tops together before tying. Sometimes shocks are not tied.

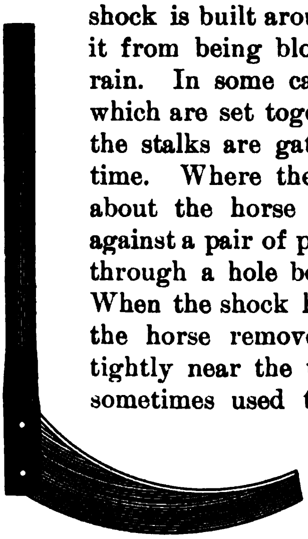
FIG. 1.—Corn hook.

After the fodder has become cured, which usually takes about a month, the shocks are generally husked by hand in the field, and the stover is commonly tied into bundles and reshocked. Frequently the stover from two or more shocks of corn is put up in a single shock. For convenience in husking a movable table is sometimes used, on which the stalks are laid while being husked. The ears are thrown in piles on the ground near the shocks and afterwards hauled to the crib. The stover is sometimes hauled to the barn and stored, but often it is left standing in shocks in the field till needed for feeding during the winter. It is important to choose suitable weather conditions for husking, since if the plants are too dry the stalks will break and blades will fall off and be lost. On the other hand, extremely wet weather makes the ground too soft for hauling in the corn.

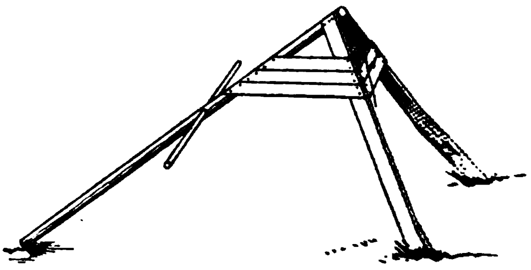
FIG. 2.—Wooden horse used to support shock.

The cost of these methods of caring for the corn crop varies wit the locality and the year. Taking the average of the replies to [illegible] inquiries, it appears that one man is able to cut and shock by hand about 34 shocks 12 hills square, or nearly 1½ acres of corn per day. The average cost per shock for cutting by hand is reported to be 6.5 cents or $1.50 per acre.

MACHINES FOR HARVESTING CORN.

SLED HARVESTERS AND SIMILAR DEVICES.

As early as the year 1820 attempts were made to construct a mechanical corn harvester. From that year until 1892 all attempts to perfect such a machine were unsuccessful. The machines invented were patterned after the mower and the reaper, but owing to the size of the corn plant these machines either would not cut at all or were soon broken under the heavy strain. Some of the machines, however, had commendable mechanical features, which were embodied in machines invented later.

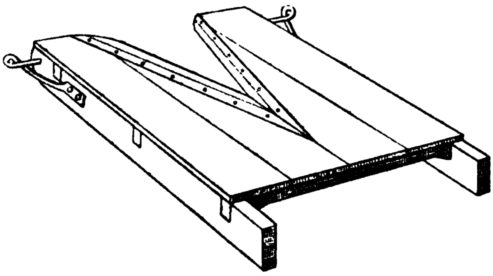

FIG. 3.—One-row sled harvester.

Homemade sled harvesters.—Many homemade harvesting devices of the sled pattern have been made from time to time, some of which are illustrated in figures 3, 4, and 5. The first harvester of this class was patented by J. C. Peterson, of West Mansfield, Ohio, who put one in the field in 1886. Others followed and added improvements until eight or ten harvesters of this kind were in the field.

With most of the sled harvesters the driver rode on the platform, and it was necessary for him to gather the stalks in his arms in advance of the cutting edge, so as to prevent them from falling in various directions. This method of harvesting was very exhausting. The harvester shown in figure 5 was an improvement, in that the guiding arm collected the stalks on the platform, and it was only necessary for the driver to pick the stalks from the sled at intervals and throw them on the ground.

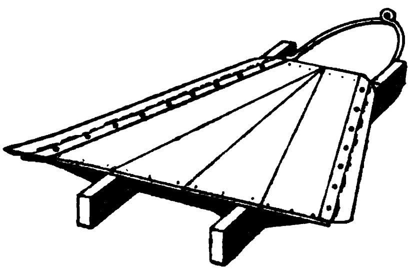

FIG. 4.—Two-row sled harvester.

A sled harvester mounted on wheels.—As an improvement, in order to reduce the draft, the sled was mounted on wheels (fig. 6). This machine cuts two rows at a time, and two men sit on the platform, one facing each row, to guide the corn against the cutting edge with one hand and with the other hand and arm to collect the cut corn on the tilting side part or wing of the platform, drawing it back against the leg, where it is assembled until enough has been collected to form a shock.

More complicated machines.—To reduce the labor involved in cutting corn with the machines described, another style of corn harvester was invented, two forms of which are shown in figures 7 and 8. This machine consists of two driving wheels, between which is mounted the frame for the driving mechanism and platform. It is drawn by one horse, which walks between the two rows that are cut at the same time. The dividers pick up the lodged corn, except such as lies in the row of corn away from the machine, and guide it to the cutting apparatus, which consists of two stationary side blades, above which is a movable sickle, which cuts the corn and deposits it horizontally on a platform that is elevated about 6 inches above the cutting apparatus. On the inner side is a guide chain, which assists in directing the stalks of corn to the knife and the platform. The rear part of the machine is provided with a small wheel, above which is a tilting lever, by means of which the dividers in front can be raised or lowered to gather up the lodged corn until it comes in contact with the endless chain, which carries it backward until it is cut and deposited on the platform. The machine shown in figure 7 has low wheels and stationary cut, while

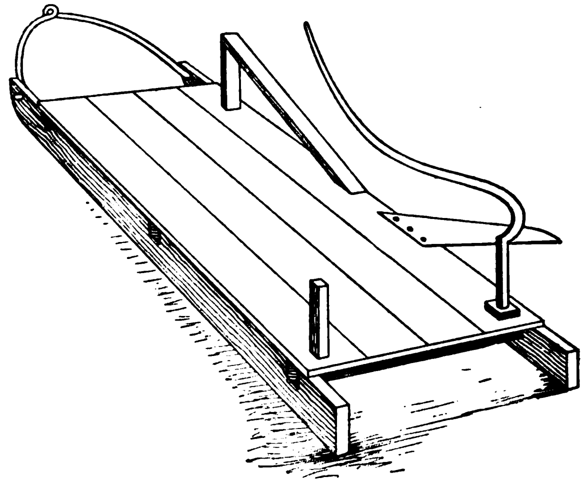

Fig. 5.—Improved one-row harvester.

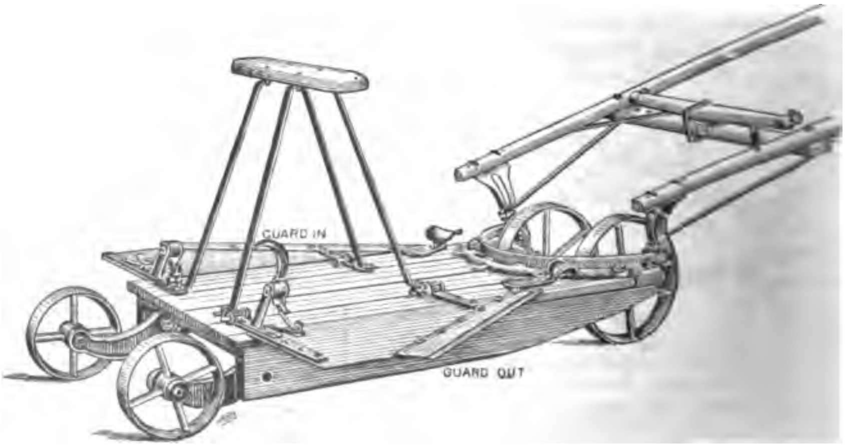

Fig. 6.—Corn harvester with automatic knife guards.

the one shown in figure 8 can, by means of side levers, be adjusted to cut the corn from 2 to 15 inches from the ground.

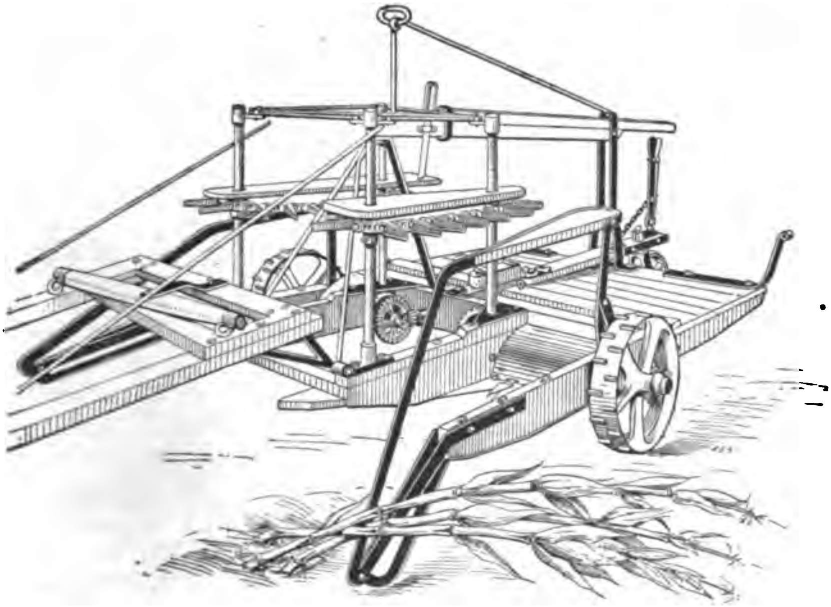

Fig. 7.—Two-row corn harvester with stationary lift.

Machines of this type gather and cut the corn and drop it on the platform. When there is enough to start a shock, the horse is stopped and the corn is set up.

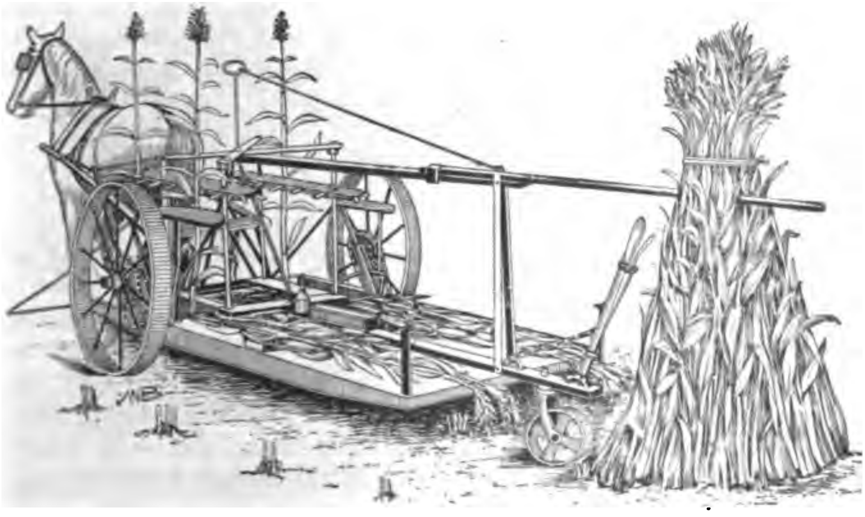

Fig. 8.—Another two-row corn harvester—rear view.

Cost and efficiency.

These different forms of corn harvesters vary in price from $5 to $55, and, while their low cost is a great advantage, their degree of efficiency is not very high. The cheap sled harvesters can be used only when the corn stands straight, and the horse must walk rather fast in order that the work may be perfectly done. It is also hard work for the men to gather and shock the corn. The work of harvesting corn is such that only the best construction can withstand the strain for any great while, and hence these machines are being used less than formerly.

From 90 replies to a letter of inquiry regarding the cost of harvesting with these machines, sent to a large number of farmers in different parts of the country, it was learned that the minimum in area of corn cut per day was 2 acres and the maximum 10 acres. The average from all the replies was 4.67 acres of corn cut per day by two men and one horse, using the sled harvester. As to cost per acre for harvesting corn the minimum price reported was 55 cents per acre and the maximum $2. Taking the average of all the replies received, the cost of harvesting corn with a sled harvester was $1.18 per acre. This is estimated on a basis of 18 cents per acre, or 84 cents per day, for the use of the machine and repairs; 4 cents per acre, or 19 cents per day, for twine; 58.5 cents per acre, or $2.75 per day, for one horse and a man who does part of the shocking, and 37.5 cents per acre, or $1.75 per day, for the other shocker. Comparing this cost per acre with that of hand cutting (p. 6), it will be noted that there is a saving of 32 cents per acre in favor of the machines. It will also be noticed that two men and a horse with a sled harvester can cut and shock 4.67 acres per day, as against 1.47 acres per day for one man with a knife, which gives a credit of 1.73 acres per day for the work of the horse, or a considerable saving in favor of the machine.

CORN BINDERS.

Historical.

The credit of inventing corn-harvesting machinery belongs to Edmund W. Quincy, of Illinois, as he obtained the first patent on a corn-harvesting machine in October, 1850. This machine, like many others, was intended to pass over the row and pick the ears from the stalks. Another form of corn harvester (fig. 9), invented in the eighties, cut the cornstalks and elevated them into a wagon. The elevator could be removed and a binder attachment put on by which the corn was bound into bundles. One of the earliest forms of corn harvester and binder was constructed as a modified form of the grain binder. This machine also was so constructed that for the binder attachment there might be substituted a device to elevate the corn into a wagon.

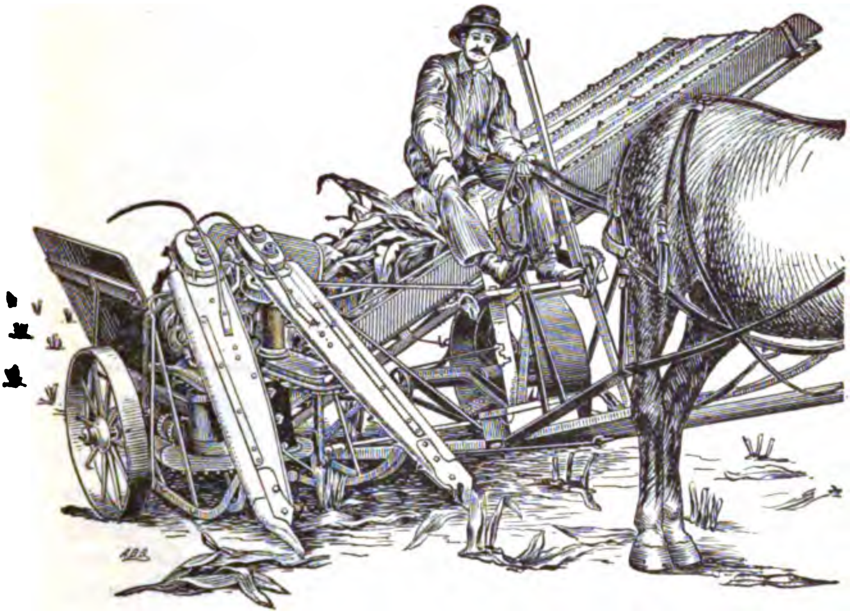

FIG. 9.—An early corn harvester.

A machine embodying principles which were destined to prevail in corn harvesters was invented by A. S. Peck, of Geneva, Ill., and was patented January 5, 1892 (fig. 10). It consisted of a corn harvester with the two dividers passing one on each side of a row of corn, which

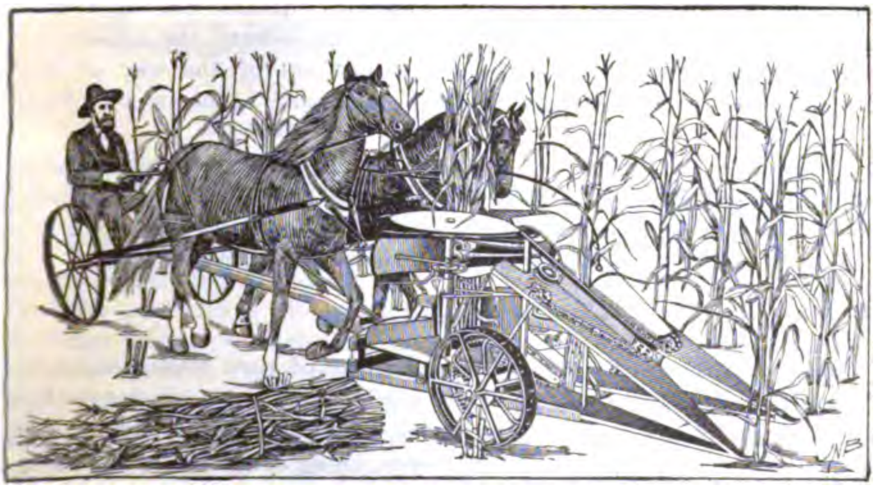

FIG. 10.—Vertical corn harvester in the field.

was cut and carried back in a vertical position to the binder attachment by means of chains and gathering arms. A standard twine binder was used, set in a vertical position so as to receive the stalks and keep them in this position until the bundle was discharged. The horses were hitched behind the machine as they are on the header.

The Peck patent received very little attention at first. It showed very few elements that were new, as the vertical principle of cutting grain had been tried and failed to give satisfaction. It was rather a rearrangement of well-known principles used in harvesting machinery than a new departure. However, after two years' use by the inventor and a few other persons, its merit was recognized by one of the prominent harvester manufacturers.

From the date of the Peck patent until 1895 many machines were made which would work well in the hands of the inventors, but few were so perfected as to be entirely successful in general use.

Since 1895 the self-binding corn harvester has had a considerable sale. In practically all of the corn binders now built the features of the Peck type predominate. Even the most divergent forms still retain the general organization of parts used in the Peck machine. Among the practical and successful corn binders in the market the widest divergence from the Peck type is probably to be found in the machine invented by John A. Stone, of Chicago. In this machine the binder is in an almost horizontal position, instead of vertical. When the corn is cut the stalks move a little rearward in an upright position, and then they are tripped so that the tops fall rearward onto an inclined deck, being guided in their fall toward the binder by curved guide arms. The butts are pushed out of the way of the incoming cornstalks, and are evened for a bundle by means of a butt adjuster.

A type of corn binder, which comes about halfway between those already described, was invented by Tarrall and Maul, of Batavia, N. Y. It is designed to occupy an inclined position over the deck for the purpose of binding the stalks in a semiprostrate position.

Construction.

There are, therefore, three different forms of corn binder, namely, the vertical, the horizontal, and the inclined, the latter being rather a blending of the two preceding types. These machines differ only in the relative position of their elements, being composed of the same essential parts. Binders consist essentially of the dividers, of which previous mention has been made, and of cutting and binding devices. (See figs. 11, 12 and 13.) A bundle carrier is usually also attached, but this is not essential to the smooth operation of the machine.

Dividers.—The dividers consist of two diverging jaws opening at the front of the machine. The jaws begin in two points at the front, but gradually widen vertically to where they join the frame of the machine, when they have a width, or rather a height, of 4 feet or more. By an arrangement of levers the points may be raised or lowered. Attached to each jaw are two or three traveling chains, whose purpose it is to bring the stalks to a vertical position and carry them back to the binding deck. The chains are placed one above the other (fig. 11). The lower one is known as the short-corn chain, the middle one is the conveyor chain, and the upper one is the tall-corn chain. The middle chain passes around a sprocket wheel close to the point of the jaws, and extends back almost to the binding deck. The upper chain begins farther back and extends some distance over the binding deck. This chain is meant to carry the tops of tall corn. The lower chain is of about the same length as the upper one, begins nearer the point of the jaw, and does not extend so far back. These chains are supplied with fingers, which take hold of the stalks and lift them to a vertical position as the machine advances. The jaws have such a position relative to each other as will bring the fingers of the opposite chains almost in touch with each other at or near the cutting blades. The chains receive their motion from the main driving mechanism, and are driven at such speed as will bring the stalks to the proper position for cutting without shaking them too severely.

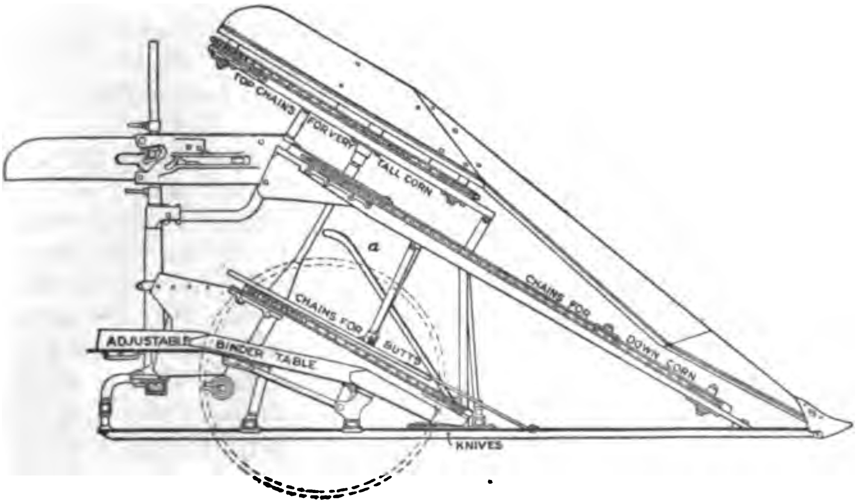

FIG. 11.—Skeleton frame of corn binder, showing chains.

Cutters.—The cutting arrangement consists of a serrated knife which passes to and fro across two stationary blades, one of these being attached to each jaw. This serrated knife is driven by a pitman attached to a weighted wheel called a "fly wheel." The added weight gives enough stored energy to sever the toughest stalks without shock to the small gear wheels (fig. 12).

Attached to the rear of the dividers and extending around the binding deck are several guide springs (fig. 10) which keep the tall corn from bending over and becoming entangled in the binding gear.

Binding apparatus.—Just behind the knife and thence extending back to the bundle carrier is the butt shoe, or butt carrier (fig. 11). This device carries the weight of the stalks after they are cut. It is fastened to the frame just behind the knife, but through the rest of its length it is adjustable vertically, so that the binding twine may be placed at the proper place on both tall and short corn.

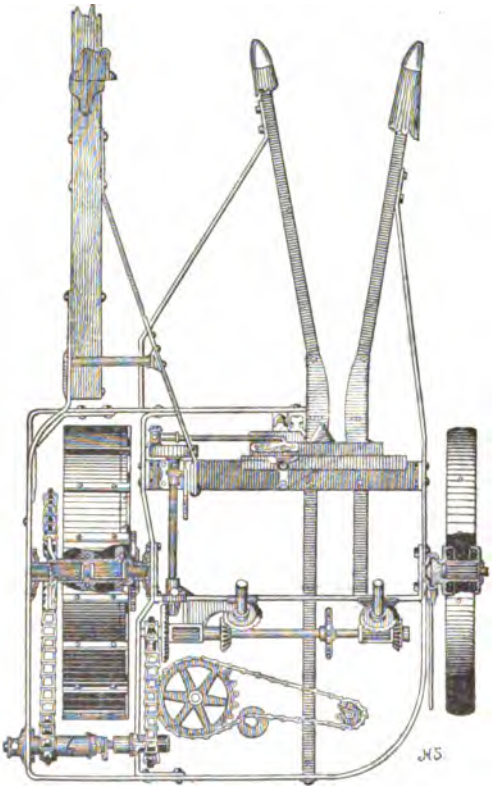

FIG. 12.—Frame of corn binder, showing mechanism for driving cutter knife, gear shaft for driving chains and binding device, and roller bearings.

As the stalks are cut they are carried back by the conveyor chain, with their butts resting in the butt carrier until they reach the binding deck, where they are pushed backward by the packers, which have such a motion as will carry them perpendicularly through the binding deck and parallel to it while conveying the stalks to the knotter. Their motion is more rapid than that of the chains, but they have the advantage of yielding slightly while a bundle is being tied. This is important, as many ears would otherwise be knocked off by jamming the stalks behind the needle.

The needle and the knotter form the binding attachments. They are in nearly all cases of the same pattern as are those of the grain binders of the same makes, but are made heavier to meet the requirements of the work.

The packers on these machines (fig. 13) must have such a motion as to travel toward the back of the machine as long as they project above the binding deck, their travel through the deck being fast and of short duration. There is one machine on the market which does not use packers at all, but has instead several chains with collapsing fingers. While the bundle is being formed, these fingers assume a position perpendicular to their chains, being held so by the guides over which they travel. As soon, however, as the needle moves, these guides no longer bear against the fingers, which collapse when pressure is brought to bear against them. This prevents their jamming the incoming corn against the rib of the needle while a bundle is being tied and avoids the breaking off of ears that would often occur otherwise.

When the bundle has been bound the two or three discharge arms on the binding shaft have reached the back side of the bundle, and by the continuous motion of the shaft the arms force the bundle off the deck and discharge it, after which the compressor hook returns automatically to its place and the binding shaft stops until another bundle is formed, when the operation is repeated. Figure 13 shows the binding mechanism and the general arrangement of the several parts referred to.

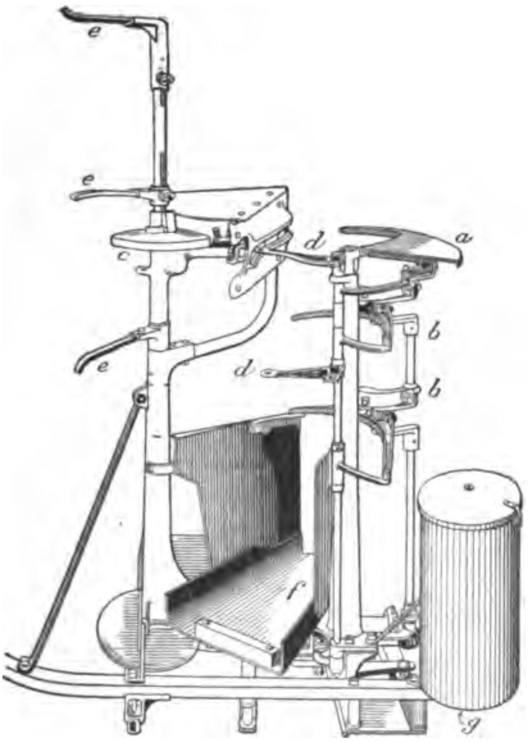

Fig. 13.—Binder attachment: *a*, Needle; *bb*, packers; *c*, knotter cam; *dd*, compressor hook; *eee*, discharge arms; *f*, butt table or butt shoe; *g*, twine cam.

Special features.—The parts that are adjustable by lever are the butt shoe, the dividers, and in some machines the binding deck and knotter and needle. The whole frame of the machine may be raised or lowered by means of the two worm-and-pinion arrangements, one on the grain wheel and one attached to the main drive wheel.

In the vertical machine the binding mechanism has a vertical position; in the horizontal machine it sits horizontally on the frame, and in the inclined machine it is inclined.

In the horizontal machine it is necessary to extend a conveyor chain farther back than in either of the other types, so as to bring the tops of the stalks into a horizontal position. In this type, too, the bundle carrier extends in a direction parallel to the length of the machine. This arrangement is very apt to give trouble from the butts of stalks becoming lodged in stubble or soft earth and spreading the bundles in disorder upon the ground. This might be avoided more or less by giving the bundle a sharp toss, thus freeing the carrier before any part of it touches the ground. The fingers of the carrier are sometimes made free to move backward and forward so as to prevent the drag above referred to. On the vertical and inclined machines there is less danger of trouble from this source, as the bundle carriers extend across the path of the machine. The smooth operation of the carriers depends greatly on the skill of the operator. Too many bundles crowd the carrier and prevent the binding attachment from properly freeing itself, causing the leaves of the stalks in one bundle to become wrapped about the stalks in another.

The tall-corn chains may be removed where the corn is short or of medium height, and in clean fields of tall corn the short-corn chains are unnecessary. In short corn the lower chain has sometimes proven inadequate alone to properly convey the stalks to the binding deck. By the addition of a small iron rod or spring (shown at *a*, fig. 11, p. 13) on each of the dividers the choking of the binding gear is prevented and a more nearly perfect bundle is made. A short iron bar has also been added on many machines to serve the same purpose. This is usually placed in a horizontal position between the lower and middle chains. The dividers are adjustable vertically, allowing them to pick up corn that is lying flat upon the ground, the lever being in reach of the driver.

To protect the mechanism from the stalks of the uncut rows a guide rod of hickory or other tough wood is usually attached to the dividers and extended as far back as is necessary. It may be raised or lowered independently of the dividers, however, so as to give protection against either tall or short corn. This bar is shown at the left in figure 14 and the tilting lever on the right.

Badly tangled fields make the progress of one of these machines slow, but it is remarkable with what precision the chain conveyors right the stalks. The adjustment is accomplished by tilting the machine forward or backward by the tilting lever, according to whether it is desired to lower or raise the points of the dividers. As the weight is almost evenly distributed on either side of the main shaft it takes but a very little power to bring the dividers into the desired position.

There are two types of these dividers—the vertical (see fig. 10, p. 11) and the inclined (fig. 14). For the vertical it is claimed that little jostling is given the corn, decreasing the danger of knocking off ears, while advocates of the inclined pattern claim to accomplish the same result by allowing the stalks to recline against the inner jaw and be carried backward between the fingers of the conveyor chain on that side.

Owing to the great variation in height of corn, even in the same field, the binding attachments are given great range of operation. In some machines they are placed as high as 32 inches. On machines of this range it is customary to have two needles, each covering half of the variation in the position of the knotter. With such a large range as this it is possible to tie the bundles sufficiently low without raising the stalks any great distance, thereby reducing the work required of the machine. In most machines the motion is taken from the inside; in some, however, it is taken from the outside hub of the main driver. (See fig. 12, p. 14.) The arrangements for reducing friction and excluding dust from the bearings receive careful attention, as may be noted from the numerous roller bearings and brass bearing boxes. Gears are also protected wherever possible, to prevent wear from dirt and grit. Where gears are not properly protected and oiled, there is apt to be a great loss of power, to say nothing of the wear. When they receive careful attention, however, the power required to move them is reduced considerably below that required for chain and sprocket. The driving power is increased by means of lugs cast or riveted on the rim of the main drive (fig. 14). They are made of various shapes, the object of all being to sink into the earth in such a way as to prevent slipping. Tubing, angle iron, and bar iron are used almost exclusively in the construction of the frames. These give strength and lightness, features which are most essential

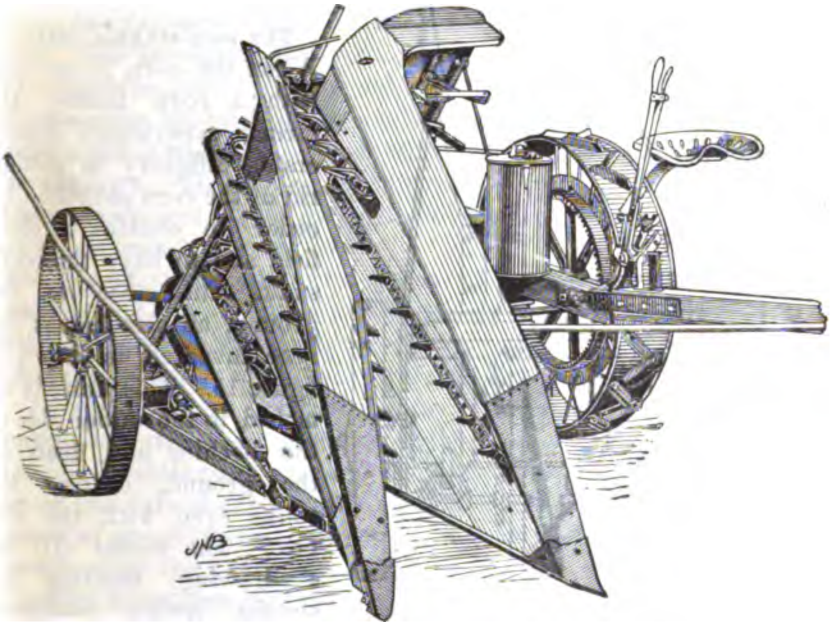

FIG. 14.—Inclined corn binder, showing tilting lever and guide rod.

to a perfect machine. The attendant, from his seat on the machine, has perfect control over all parts. The levers at his side operate all adjustments, and the position of the bundle carrier is controlled by a foot-lever attachment.

These machines weigh, complete, from 1,400 to 1,800 pounds. Generally speaking, those weighing in the neighborhood of 1,500 pounds have been most successful, this weight seeming to give the proper relation between driving power and durability.

The corn binder is used to greatest advantage in fields where the corn is check-rowed, as it is possible to cut around a block, keeping the machine constantly in operation.

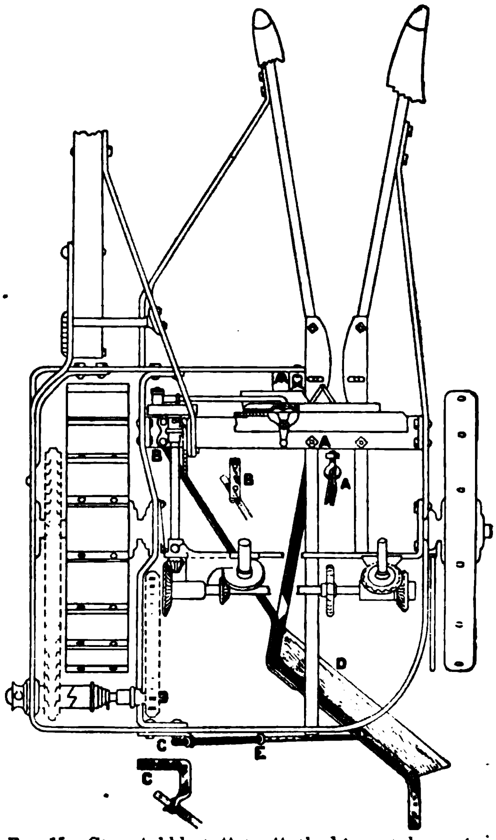

FIG. 15.—Corn-stubble cutter, attached to corn harvester.

The corn-stubble cutter.—When the corn is cut high with a corn binder, the farmer experiences considerable difficulty in getting rid of the corn stubble. In order to obtain a clear field and to have the cornstalks cut close to the ground, an attachment has been invented as shown in figure 15. This knife is attached to the under side of the machine and floats on the ground, cutting the stalks even with the surface. The cutter (D) has a drawing, slanting cut against spring resistance (E), making a clean cut. When this attachment is used, the binder is usually set to cut higher. The stubs, if cut when sappy, will decay quickly, and are left on the ground to form humus in the soil; and the ground may be prepared for the next crop with greater thoroughness.

Draft.

The average draft of corn binders is about the same as that of a 6-foot grain binder. The corn binder should therefore be propelled by three horses, the same as are required for grain binders. Draft tests of the corn binder, with a stubble-cutter attachment, shows the following results:

Draft of corn binder with and without stubble cutter.

	Pounds.
Draft with stubble cutter	437
Draft without stubble cutter	420
Draft of stubble cutter	17

Cost and efficiency.

The average results, taken from the several hundred replies received to a letter of inquiry, indicate that for all conditions of corn the average number of acres of corn cut per day with a corn binder using three horses was 7.73 acres. The average number of acres which one man can shock per day after a corn binder was 3.31 acres. The average number of pounds of twine used per acre of corn cut was 2.44. The average life in years of corn binders was 8.17, and in acres of corn cut 668.77. The average first cost of corn binders was $125. The average cost of machine per acre cut, which includes price of machine, repairs, and interest on the investment, was 29 cents per acre; the cost of driver and team per acre cut 46 cents, or $3.55 per day; the cost of twine 30.5 cents per acre. The cost of shocking the corn after a corn binder is 44.8 cents per acre. This gives the total cost per acre of harvesting corn with a corn binder, $1.50.

The cost of cutting corn with the corn binder is therefore the same as the cost for cutting corn by hand, and 32 cents per acre higher than the cost of cutting with a sled harvester. This extra cost of cutting with the corn binder over the cost of cutting with the sled harvester may be attributed to the cost of the twine and the interest on the investment in the higher first cost of the machine.

One disadvantage in the use of the corn binder is that it knocks off more or less ears of corn, which either have to be picked up by hand, at a cost of about 10 cents per acre, or left to waste or to be found by the cattle after the field is cleared.

Farmers sometimes hire their corn cut at a rate of 75 cents to $1 per acre for the use of the machine, the driver, and the team. The average cost of cutting given above was 29 cents per acre for the use of the machine and 46 cents per acre for the driver and team, or 75 cents per acre. The charge for hiring the work done is only slightly above this.

THE CORN SHOCKER.

Although the earlier efforts were centered upon the construction of the corn shocker, the perfection of this machine was delayed until after the introduction of the corn binder. In the first machines the inventor attempted to engage the stalks by extending rods or springs in advance of the cutting knives, but this did not prove as successful as did the dividers of the corn binder. With these the corn could readily be brought to an erect position and thus made into a perfect shock.

Description.

The present corn shocker was invented in 1888, and a machine was constructed that year by A. N. Hadley. It was built with a frame mounted on two wheels, the same as the corn binder, and consisted of a corn-gathering device—revolving reels on vertical standards—the upper bearings of which were arranged for adjustment laterally and fore and aft. It had as a cutting device two circular rotating cutters, operating against each other and cutting the corn as the machine advanced toward it. Behind the cutting device was a circular rotating table, 5 feet in diameter, upon which the corn was collected vertically to form a shock. On this table were several radial ribs, which aided in revolving the standing corn. In the center of this table was a rotating shock-forming standard, having radial arms around which the corn was collected. A revolving crane was mounted on the frame and a rope and pulley attached above the shock, by which it could be lifted from the platform and deposited on the ground.

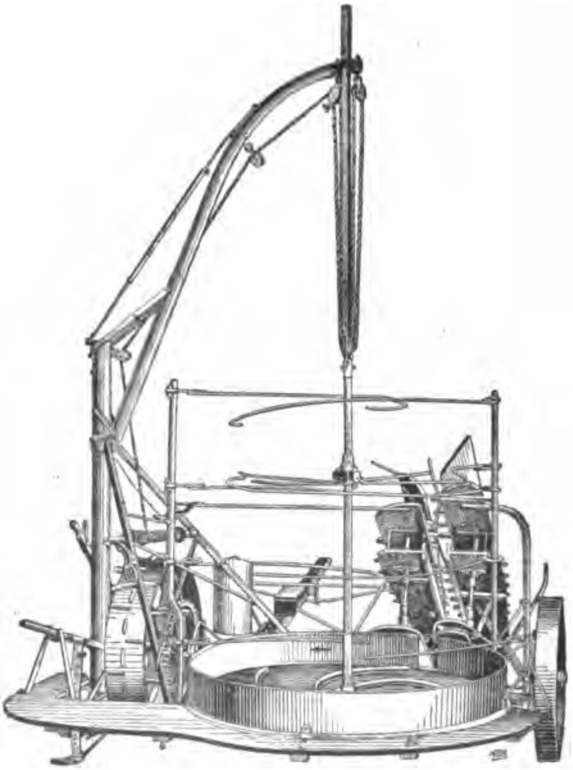

FIG. 16.—Corn harvester and shocker.

In 1893 a shocker was constructed by J. M. Shively, similar in principle but somewhat departing in its construction from the Hadley shocker in that the cutting apparatus and the dividers were like those of the corn harvester, and the retaining wall surrounding the shock-forming table was somewhat higher than that on the Hadley shocker.

The present form of shocker (fig. 16) consists essentially of the dividers already described in connection with the corn binder, a revolving table for assembling the shock, and a crane for removing it. The knives and fly-wheel attachment for cutting the stalks, and the arrangements for raising or lowering the dividers, and the frame are similar to those used on the corn binder. The table revolves in the direction indicated by the arrow, and receives its motion from a bevel gear driven from the main drive and meshing into a rack on the outer edge of the table. As the machine advances the stalks are carried through the opening in the guard band. They are then caught by the spiral plates and the arms and forced around the central post. The arms also revolve, receiving their motion through the central pin from a gear located just beneath the table. Their motion is somewhat slower than that of the table. The guard or tension springs keep the stalks firmly compressed about the central post. Sometimes the twine is tied to one of the arms and allowed to assist in bringing the stalks toward the center by being wound about them as the arms revolve. This practice adds to the expense of operating the machine and does not materially improve the character of the work. At the outer edge are posts which support the tension springs.

When the shock is fully assembled on the table it must be tied by hand. The shock may then be raised from the table by turning the crank, and winding the rope about a spool. The shock must be lifted high enough to clear the retaining wall. The tension springs are swung aside and the crank acting on a sector gear swings the shock free from the machine.

The arms (fig. 16), which are held in a horizontal position by the weight of the shock, are released the instant the rope is given slack. This release of the arms is brought about by a unique arrangement of a cam and pawls. When the rope is tight owing to the weight of the shock, the pawls are held in the grooves of the cam because the weight is carried from the pulley. When the rope is given slack the pawls are no longer kept from slipping out of the grooves in the cam, the shock moves through a small arc of a circle and drops to the ground, and the central supporting post is then raised to its position on the machine. The whole operation of forming, tying, and setting a shock can be done in five minutes. The shocks are somewhat smaller than those ordinarily made where corn is cut by hand or with a binder, averaging about 100 hills per shock, but the smaller size is necessary and makes it possible to reduce the weight of the machine. The smaller shocks also tend to cure more rapidly. The adjustment of the frame admits of the low cutting of the stalks. This results in a greater weight of fodder per acre and leaves a short stubble that is easily turned under at the spring plowing.

Cost and efficiency.

Corn shockers cost about as much as corn binders and weigh approximately the same. The shocker has the advantage of requiring the work of but one man, whereas the binder requires, besides the driver, two or three men to follow and shock the corn.

The replies to inquiries indicate that the average number of acres of corn which can be cut per day with a corn shocker, three horses, and one man, is about 4.7 acres. The wear and tear is less than on a corn binder, and the life of the machine ought to be greater. Assuming that the allowance for first cost, life of machine, and interest on investment is the same as that for the corn binder—i. e., 29 cents per acre; allowing $3.55 per day for driver and team, or 75 cents per acre; and estimating that the twine required per acre cut with the shocker will not cost over 2 cents, we have a total cost of harvesting corn with a corn shocker of $1.06 per acre, as compared with $1.18 per acre for harvesting with a sled harvester, and $1.50 per acre with corn binders or by hand.

The shock made by the corn shocker is not so easily loaded on a wagon as is that made by a corn binder, as the individual bundles may be loaded with a pitchfork, whereas the whole shock made with a shocker can best be loaded at once, and this requires some form of loading device or horsepower derrick.

The corn binder is well adapted for cutting corn for the silo, as the bundles are bound into convenient size for handling, but this saving of labor is accomplished at the cost of twine. A corn shocker arranged to load the shocks on a wagon would no doubt prove the cheapest method of harvesting corn for the silo.

The general verdict of farmers who have used both the corn binder and the shocker is that the shocker is the preferable machine for harvesting corn.

A CORN-SHOCK LOADER.

A loading device for handling the shocks adds greatly to the value of the shocker, for with it the corn can be more cheaply handled than by the present methods. One of the first devices of this kind consisted of a long pole or pipe supported on a fulcrum at the rear end of the wagon in such a way as to give considerable leverage. The idea was much like that of the old well sweep with the semirotary motion added.

An improved loading device which can be carried along with the wagon or left in the field and driven about independently, is mounted on four wheels, and consists of an adjustable vertical mast on which is a horizontal steel cross arm. On this is mounted a traveling block fitted with pulleys through which a rope passes. To the end of this rope is hitched a horse which lifts the load. For loading corn shocks a grapple fork is used, which is slipped under the shock. The grapple arms are closed and with the pull of the horse the shock is lifted up on the wagon and laid on its side or stood on end, the grapple arms being released by simply turning the handle of the fork. This machine was originally designed to load corn shocks, and easily handles two shocks per minute, and will bear a stress of 2,000 pounds. It can also be applied to many other uses, such as loading hay, manure, small grain, dirt, lumber, telephone poles, and other heavy objects.

CORN PICKERS.

In the so-called "corn belt," where corn is the principal crop raised, it has not been possible so far to utilize all of the cornstalks. The crop is raised for the ears, which are picked by hand at maturity. To relieve farmers of this somewhat tedious work, for which it is often difficult to get sufficient labor, inventors have been busy for over fifty years trying to build and perfect a machine to pick the corn from the stalks.

DESCRIPTION.

A picking machine was invented by Quincy in 1850, and another by William Watson, of Chicago, shortly after. Practically all of the earlier corn pickers consisted of rollers inclining up in such a way that the front end of the rollers would pass below the lowermost ears and rake the stalk from the bottom to the top. A great many devices were employed for removing the ears, such as cutters, gathering prongs, rotating-toothed cylinders, roller and breaker devices, parallel vibrating bars, etc. The early machines were designed to be pushed from the rear and were provided with some form of dividers to guide the corn to the snapping devices, as shown in figure 17. The snapping-roller type of corn picker received serious attention from manufacturers about 1874, when the first machine of this type was invented, but it was ten years later that it was patented. The rollers were placed in the inclined position for the stalks of corn to pass between them. The end portions of the rollers where the stalks entered were provided with bars designed to aid in snapping off the ears as the stalks passed down between the rollers during the advance of the machine. For the remainder of their length the rollers were so constructed as to tear the husks from the ears and continuously feed the ears along, to be finally discharged, husked, onto a conveyor, and delivered into suitable receptacles. This particular machine was

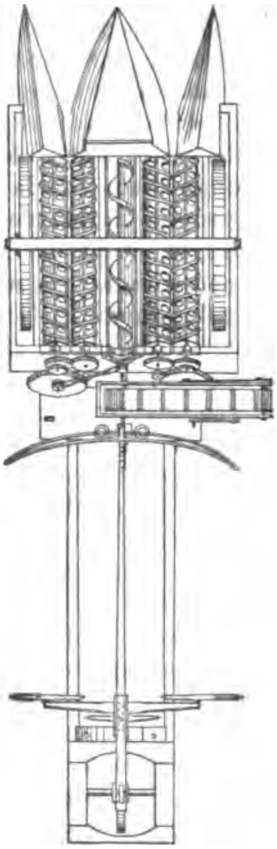
FIG. 17.—A corn-picking machine.

thought to promise success, but when the corn binders began to be developed and came into use the interest in corn pickers abated, as it was thought that with a successful corn binder there would be no need of corn pickers. However, the use of the corn binder and the shocker, while quite extensive, does not solve the corn-harvesting problem in the purely corn-raising regions, where a large share of the corn is still picked by hand from the stalks as they stand in the field.

About 1902 the attention of manufacturers was again turned to corn pickers, and several machines are now being introduced for picking corn. The corn picker as now constructed resembles the corn binder in the construction of the main frame, drive wheels, and dividers. It passes along the row of corn, which is straddled by the dividers, and the stalks, after being righted by the points, chains, and other devices, pass between a pair of inclined, corrugated rollers that snap or strip off the ears. The rollers are so placed that the ears fall naturally into a trough that extends along beside them. In order to provide snapping rollers to remove the ears and force them to fall always to the same side, yet permit free entrance of the upright stalks at the receiving end without the necessity of auxiliary means to bend the stalks laterally, James E. Goodhue arranged the snapping rollers in slightly skewed relation, by which the upright stalk may be gradually forced to one side as the picking rolls pass along, and the ears are broken off and directed to one side. The ears are carried back by a traveling conveyor and either delivered to a set of husking rolls or else, without being husked, carried by an elevator and delivered into a wagon which is driven alongside the machine.

Another form of modern practical corn picker has the guide chains with the usual prongs for straightening up the stalks. The chains form a stalk passage extending rearward through the machine. A rapidly moving chain provided with fingers is located at one side and between the guide chains in such a position that, as the machine passes over the row, the fingers engage the ears on the stalks and snap them off. By means of a deflector the ears are directed to a receptacle from which they are carried to the husking rollers and thence to the wagon. The tops of the cornstalks are cut off, and by means of a conveyor this and other trash is carried to the rear and dropped on the ground.

OBJECTIONS AND ADVANTAGES.

The corn picker is intended to remove the ears from the stalks, which are left in the field. Most of the machines are built on the assumption that the stalks are valueless, and therefore they are practically destroyed. It has not been possible to construct a picker that will not to some extent break down or tear down the stalks. This is somewhat objectionable because, where the corn is picked by hand, the dried corn leaves and stalks serve as roughage for cattle during the fall and winter. The machine has, however, this advantage, that the field can be picked quicker and the cattle turned in earlier to make use of the roughage before the snow falls.

Another objectionable feature of the corn picker as compared with the hand method of picking corn is that it shells considerable corn; and, if the corn is lodged and tangled, more or less ears are missed by the machine. The corn picker with the husker attachment requires considerable motive power, at least four horses being required to pull it. For this reason some manufacturers have dispensed with the husking attachment and depend upon the snapping rollers for removing most of the husks. Machines of this kind will remove from 25 to 75 per cent of the husks, depending upon the stage of maturity of the corn, the brittleness of the stalks, and the effects of freezing and damp weather. Where machines without the husker attachment are used a stationary husker may be provided at the crib, in which the corn is husked and elevated into the corncrib.

There is a variance of opinion among the farmers as to the advisability of husking the ears clean. In the South the common practice is to leave the husks on the ears, and it is claimed that this practice tends to prevent injury by insects. In the North it is the common practice to husk the ears clean before they are cribbed. The objections offered, in reply to inquiries, to using a corn picker which leaves the husks on the ears are that more crib room is required for the ears; that they will serve to attract and harbor rats and mice; that the ears will not dry out, but will be liable to mold; that the husks interfere with the shelling; that, while for feeding cattle and hogs the husks will be advantageous, as they will serve as a roughage, horses will toss the ears in trying to remove the husks, and thus lose ear and all. For selling purposes the corn needs to be husked clean in order to command the best market price.

COST AND EFFICIENCY.

The corn picker should last about as long as the corn binder, or 8.17 years, and pick about the same number of acres per day as can be harvested with a corn binder, or 7.73 acres. The first cost of the machine is, however, practically twice that of the corn binder, or, on an average, $250. This makes the cost of machine, interest on the investment, and repairs equal to 58 cents per acre. The cost of driver and team is $3.55 per day, or 46 cents per acre. There is required two wagons with teams to remove the corn from the machine and deliver it into the crib, which, at $3 per day for each, costs $0.77 per acre, or a total cost of $1.81 per acre for picking corn with a corn picker.

From 300 replies received to questions sent to numerous farmers in different parts of the country it was learned that the average yield of corn was 44 bushels per acre; that the average cost per bushel for picking corn by hand was 3¼ cents, and that the average man picked 59 bushels of corn per day. This yield is considerably above the average given in the crop reports of the United States Department of Agriculture, but it represents the yield of corn in States where pickers are used. Considering, now, that the number of acres which the corn picker can cover per day is 7.73, this would, for the average yield, be 341 bushels of corn per day. It would require the time of 3.8 men to do the same work in the same time by hand as is done with the machine, at a cost of $11.93 for labor, but in addition to the wages of the men there is need of a team and wagon for every two men who pick corn by hand to haul the corn to the crib. These teams are worth at the very least $1 each per day, or three teams for the 7.73 acres would cost $3. The total cost for picking the same number of acres of corn by hand as can be picked with a corn picker, per day, would be $14.93, or $1.93 per acre, as compared with $1.81 per acre for machine picking. While the saving effected with the corn picker is not large, the use of a machine makes the farmer more independent of the labor market, as the work may be done without hiring extra men at a time when they are hard to secure. But the advantage of hand over machine picking in the removal of the husks should not be overlooked.

The corn picker is still an experimental machine, and not until it has been perfected should the farmer purchase it.

HUSKERS AND SHREDDERS.

SIMPLE HUSKING DEVICES.

One of the earliest devices used for husking corn was the husking peg. Several patterns of this are in common use. There are also other aids to corn husking made in the form of gloves, with projecting points or pegs. Equipped with such a glove the man husks the ears by tearing off the husks and snapping the stems.

EARLIER MECHANICAL HUSKERS.

The first patent on a corn husker was issued in 1837. The machine comprises essentially a pair of roughened parallel rollers designed to tear off the husks.

In 1866 a New York concern began the manufacture of a husk having a single snapping roll made of hardwood. Another roller with stiff knives located just behind the hardwood roller cut the stalk into short lengths. The ears of corn, as they were broken off by the snapping roll, fell down upon the husking rolls. These were about 2 inches in diameter and rotated toward each other. A small revolving shaft set with spikes and located directly above the line of contact of the husking rolls caused the ears to revolve so as to present all of the husks to the action of the husking machine.

Another form of husker consisted of a snapping roll much the same as that described above and several husking rolls whose effectiveness depended upon the action of rubber aprons. These passed over each roller like belts over a pulley and tended to draw the husks in with them. Later, about 1880, Phillips and Jones added to this idea by putting on a pair of snapping rolls. These were the first really successful huskers.

COMBINED HUSKERS AND SHREDDERS.

Thus far no machine had been produced designed to perform more than one operation on the stalks, except some of the unsuccessful and later experimental harvester types designed to pick and husk the ears, as previously described. Between 1880 and 1890 a great deal of attention was given to thrashing corn. This practice so battered the stalk as to make every part of it available as a cattle food, putting it in more palatable form than the ordinary fodder cutters then in use. The repeated shortages and failures of the hay crop during the decade 1880–1890, together with the results of attempts at thrashing corn, led to the invention of the combined husker and shredder, which takes the stalks with the ears on them, removes the ears, husks them, and prepares the stalks for feeding. A combined husker and shredder patented by J. F. Hurd, of Minnesota, in 1890, application having been filed in 1887, is one of the earliest of the shredder type.

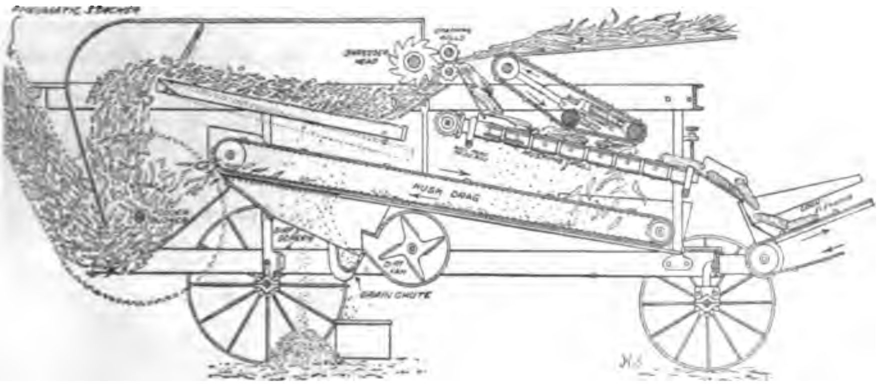

FIG. 18.—Skeleton of husker and shredder.

There are at this time many different makes of this machine in the market. They are of various designs and are frequently made so as to be fitted with exchangeable cutter and shredder heads. The general construction of all machines of this class is very much the same, however. Some are rather complicated in their construction, while others are very elementary. By referring to figure 18 the construction will be easily understood.

The stalks are first fed to the snapping rolls, where the ears are broken from them. The stalks are driven forward by the snapping rolls until they meet the shredder head, where they are cut to shreds by knives of special forms shown in figure 19. The shredded parts of the stalk fall upon a vibrating carrier whose motion is complemented by the action of arms. The shreds fall from this carrier into the blast from the fodder blower, which carries them up through the stacker.

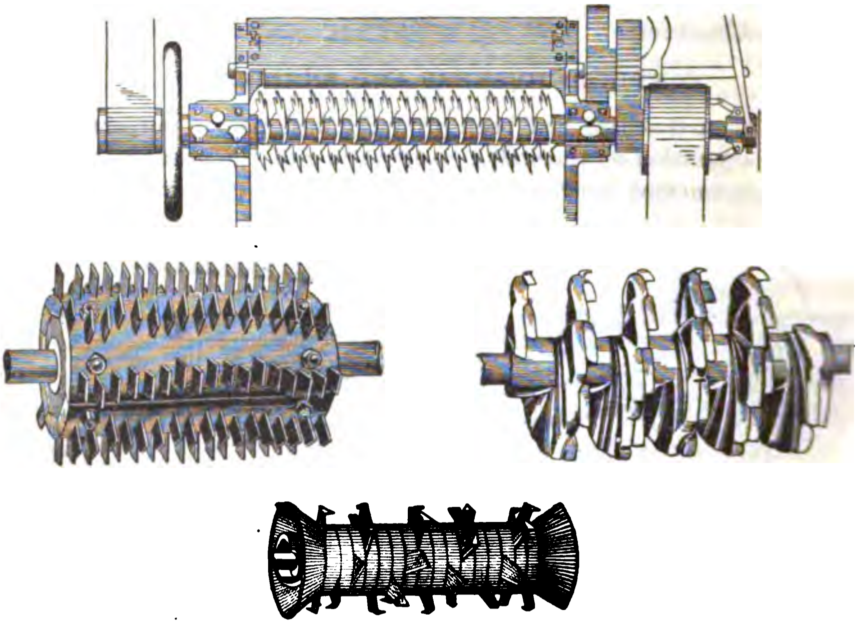

FIG. 19.—Forms of shredder heads.

The ears which are broken from the stalks by the snapping rolls drop upon the husking rolls, where the husks are torn from them. The husked ears gradually descend along the inclined husking rolls until they finally fall upon an elevator which carries them to the bin or other place provided for them.

The husks fall upon a conveyor chain which drags them back to the fodder blower, where they join the shreds from the stalk. The loose grain falls from the vibrating carrier and husk conveyor upon a screen. As it falls it is met by a mild blast, which removes the dust from it.

This grain is then collected in a trough or chute and is driven by means of a screw conveyor to one side of the machine.

This machine combines in its construction many elements used in earlier machines, both huskers and fodder cutters. The snapping rolls and husking pegs are both ideas found in machines described in preceding paragraphs, while the shredder heads are not greatly different from those of the fodder cutters of earlier design. The blower and cleaning and carrying devices are very much like those of the thrasher. Self-feeding and safety devices are now largely used as a protection against the danger of having one's hand or arm caught in the mechanism (fig. 20). Where the self-feeder is used, a revolving band cutter is commonly placed a little ahead of the snapping rolls.

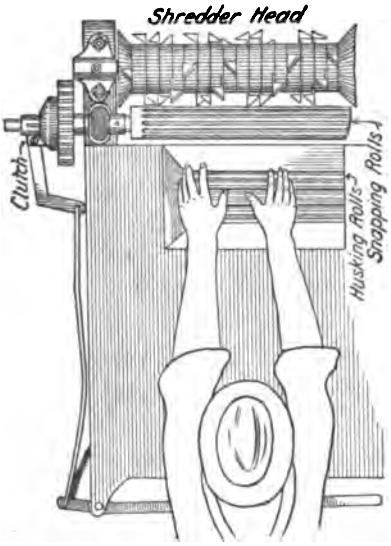

FIG. 20.—Safety device for shredders.

The superior convenience of having the stalks bound into bundles is most evident where these machines are used. In bundles the stalks keep straight and thus avoid the delay caused by having them come to the machine in a disordered condition. There is also less danger of choking the machine.

ECONOMY OF CORN-HARVESTING MACHINERY.

HARVESTING WITH THE BINDER.

We have found that the average life of the corn binder is 8.17 years and the cost $125. If a man has only 20 acres of corn to cut per year the cost for the use of the binder for each year would be $15.30. To this should be added $7.20 for interest, making the total annual cost of the machine $22.50. Other expenses for cutting the 20 acres of corn, according to the previous averages derived, would be $9.20 for team and driver, $6.10 for twine, and $8.96 for shockers; or a total cost for cutting 20 acres of corn with a corn binder of $46.76, or $2.34 per acre. We have seen that the work may be done by hand for $1.50 per acre and that by hiring a neighbor's team and binder at 75 cents per acre the work may also be done for $1.50 per acre. . We may then conclude that a farmer who has only 20 acres of corn to cut per year, and does not intend to cut any for his neighbors, would lose money by purchasing a corn binder.

If a farmer has 30 acres of corn to cut per year the annual cost of the machine, including interest, would be 75 cents per acre. It will require a cut of at least 80 acres per year before the farmer can properly estimate the cost per acre for the use of the machine to be 29 cents, as already given. It may, therefore, be concluded as a general proposition that unless this number of acres is available for cutting each year the investment in a corn binder is not profitable.

These estimates may not be exactly fair, because if the corn binder cuts but 20 acres per year the life of the machine with proper care would probably be considerably longer than eight years. There is no doubt that in general half the money spent for implements could be saved if they were given better care when in use and when not in use protected in an implement shed from wind, rain, sunshine, and farm animals. In general it is better not to invest in expensive implements unless there is sufficient work in sight to make them profitable.

PREPARING CORN FODDER.

The cost of preparing corn fodder by the various methods and with the different machines depends upon a great many variable factors. It depends upon the yield of corn per acre; upon the method of harvesting; upon the distance the fodder is to be hauled, the size and efficiency of the working force, the size, capacity, and speed of the machine, and the motive power used.[a]

We have already learned the cost of cutting the corn and putting it into shocks, and also that the average cost per bushel of husking corn from the shock in the fields is 5.3 cents per bushel, or at an average of 44 bushels per acre the cost will be $2.33 per acre. To this should be added about 35 cents per acre for hauling the ears to the crib, or a total of $2.68 per acre for husking the corn by hand. and this leaves the stover in the field. If the stalks are hauled to the feed lot it will involve an additional cost. When huskers and shredders are used for husking the corn and shredding the fodder the farmer will have to decide the question as to what method of doing the work he desires to employ. There are machines on the market which will husk but 100 bushels per day and there are those which will husk 1,000 bushels per day. The smaller ones are for the farmer who desires to do his own work.

With the general introduction of the gasoline engine on the farm a small individual outfit is very desirable. With such an outfit the farmer may do his work at his convenience, as he needs the corn and the fodder, and may also do some work for neighbors, which will aid in paying for the machine. It requires one man to feed; one to look after the engine, shredder, and the corn in the wagon; one man in the mow to remove the fodder, one to unload the wagons, two teams, and one loader in the field. Six gallons of gasoline will supply the fuel for a ten-hour run. The computed cost would be:

---

[a] The question of methods and cost of preparing silage from corn is discussed in U. S. Dept. Agr., Farmers' Buls. 32 and 292, and need not be further considered here.

Cost of shredding corn.

Use of engine and shredder and repairs, per day	$1.00
Five men, at $1.50 each	7.50
Two teams, at $3 each	6.00
Power, 6 gallons of gasoline, at 15 cents per gallon	.90
Total cost per day	15.40

From experiments conducted by the author with the above outfit it was found that the number of bushels husked per hour varied considerably with conditions, but that the average was 18 bushels, or 180 bushels per day. This, at the average yield of corn per acre previously derived, would be equal to 4 acres per day. To husk 180 bushels by hand and put it in the crib would cost $10.96. This would leave a cost of $4.44 for 4 acres of corn fodder shredded and delivered in the mow. The average yield of shredded fodder is 2 tons per acre. This would give a cost of 55 cents per ton for hauling the fodder from the field, shredding it, and placing it in the barn ready to feed. When corn has been husked in the field and the farmer wishes the fodder shredded it costs him about $1.50 per acre for shredding the fodder by machine.

With large machines the work of husking and shredding corn is usually custom work. The owner of the machine furnishes the shredder and engine, with two men, charging the farmer from 4 to 5 cents per bushel for this work. The farmer will have to furnish the fuel and the teams, as well as the balance of the help, to run the machine. These large machines require from 6 to 8 teams and 20 to 25 men for full operation. The large machine, while it does the work quickly, has the disadvantage of requiring a large crew of men and teams and if anything goes wrong with either engine or shredder this force is idle at the expense of the farmer until the machine is repaired.

From some investigations conducted by sending out letters of inquiry from the Iowa Experiment Station to all parts of the State, the following results were obtained:

> From the entire number of reports received the average cost of machines for shredding was $1.55 per acre; the cost of fuel was 31.4 cents; and the total cost of shreding, per acre, varied from $2.45 to $6.65. This is a wide range, but the conditions under which the shredding was done varied correspondingly according to the distance hauled, yield of stover per acre, kind and size of machine used, and work required in moving the outfit; also as to physical conditions of the fodder and accidents with machine.
>
> The average cost of shredding 1,600 acres was found to be $4.41 per acre, and this is believed to be a fair average under ordinary conditions.

The estimate of yield of corn per acre in the above case was 57.25 bushels, which is rather high, even for Iowa; the yield of fodder 2 tons per acre, and the cost of husking in the field 5 cents per bushel. At these figures the cost of shredding the fodder would be 77 cents per ton.

SUMMARY.

Summarizing the comparative returns per acre of husking corn from the field, of cutting and feeding from shock, and of cutting and shredding by the various methods, it is found that the net value of the crop is $17.93 for husking by hand and leaving the stalks standing in the field. This is obtained by adding to the net value of the corn 55 cents per acre for the stalks and subtracting the cost of husking by hand.

By allowing 25 cents per acre as the value of the fodder in field where a corn picker is used, and adding this to the net value of the corn and subtracting $1.80 per acre for picking with the machine, we derive the net value of the crop of $17.81 for this method of harvesting, which indicates a small loss per acre as a result of using the corn picker.

The net value of the crop by feeding the stalks whole ($23.18 for hand husking, $23.50 for harvesting with large machines, and $23[illegible] for small machines) is obtained by taking the total value of the corn and fodder and subtracting the costs of cutting and husking by hand, cutting with sled harvester and husking by hand, and cutting with corn shocker and husking by hand.

The net value of the crop by utilizing the fodder in the shredded form ($24.68 for hand harvesting, $25.45 for harvesting with large machines, and $26.45 with small machines) is obtained by assuming a greater value of shredded fodder over whole cornstalks of 33 per cent, adding this value of the fodder to the value of the corn and subtracting the various costs of cutting, husking, and shredding the corn by the various hand and machine methods.

CONCLUSIONS.

The farmer who would secure the full value of his corn crop should secure the fodder with as much care as he gives his clover hay, harvesting it at the proper period, and not allowing it to become ruined by rain or frost. By the use of the proper machinery for harvesting the corn crop, the farmer may considerably increase the net income from his crop over hand methods of harvesting the ears and wasting the stalks and still allow full price for the use of the different machines.

There is a limit beyond which it is not profitable for a farmer to invest in corn-harvesting machinery, and the amount of work to be done by the machine each year should be carefully considered before a purchase is made.

Issued September 17, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

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FARMERS' BULLETIN 304.

GROWING AND CURING HOPS.

BY

W. W. STOCKBERGER,
Expert, Drug-Plant Investigations, Bureau of Plant Industry.

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1907.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., June 14, 1907.

SIR: I have the honor to transmit herewith a paper entitled "Growing and Curing Hops," by Dr. W. W. Stockberger, which has been submitted by Dr. R. H. True, Physiologist in Charge of Drug-Plant Investigations, and I recommend that this paper be published as a Farmers' Bulletin to supersede "Hop Culture in California," issued as Farmers' Bulletin No. 115.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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GROWING AND CURING HOPS.

INTRODUCTION.

In keeping with the great progress made in agriculture within recent years the methods employed in hop production have not remained unchanged. Nevertheless certain practical principles of great importance to successful hop growing merit a much wider consideration and use than they now enjoy. These will be discussed in the following pages, in which is also presented a brief general outline of hop culture.

It is manifestly impossible to give a detailed account of methods of hop growing which would apply in all sections of the United States. The peculiar conditions of soil, climate, and location influence the prevailing methods of culture as well as the varieties grown and render it necessary for the practical grower to adopt those methods which, according to his experience, are best suited to his conditions.

CONDITIONS ESSENTIAL TO HOP GROWING.

CLIMATE.

The hop plant can be grown generally throughout the United States, but at present its commercial production is practically restricted to areas situated in the States of Oregon, California, New York, and Washington. Small quantities are raised in Wisconsin, Idaho, Massachusetts, Pennsylvania, Michigan, Vermont, Kentucky, and Ohio. The accompanying map (fig. 1) indicates the distribution of the hop-growing regions in the United States and shows graphically how the industry has become sharply localized in districts which furnish the most favorable conditions. Long and severe winters frequently kill out many of the plants, and continued damp or foggy weather is usually followed by severe attacks of lice or mold.

While from the map it appears that hops are grown under very different climatic conditions, they are produced most successfully in the milder regions, where abundant early rainfall is followed by warm dry weather as the crop approaches maturity. The accompanying chart (fig. 2) shows the average monthly rainfall in the chief hop-raising sections of the United States. In the Yakima Valley, Washington, where the rainfall is very scanty, irrigation is necessary. The hop plant readily adapts itself to very different conditions of rainfall, but when the harvest months—August and September—are accompanied by much rainfall the crop frequently suffers heavy damage from lice and mold.

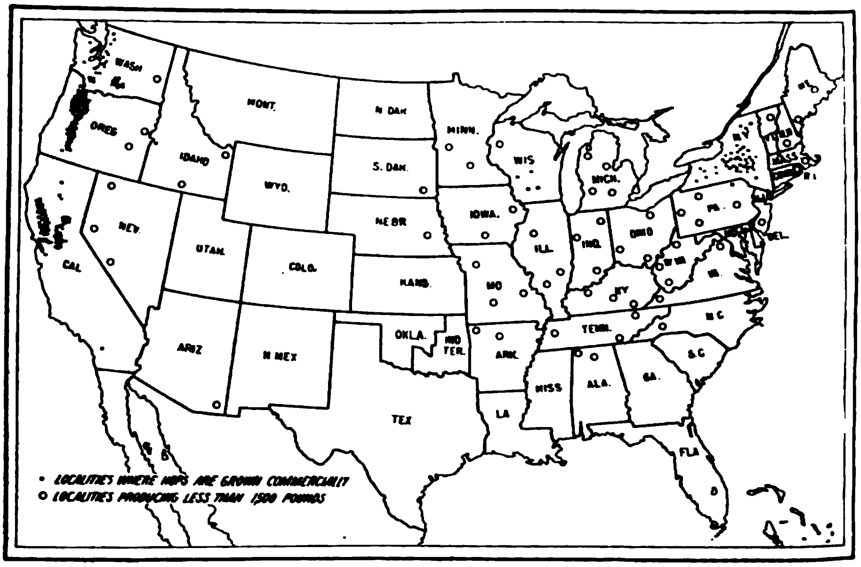

FIG. 1.—Map showing the hop-producing areas of the United States.

SOIL.

The selection of the best soil on which to grow the hop plant involves the consideration of several factors, depending on the peculiarities of the plant itself and the physical conditions of the region in which the land lies. In general, rich alluvial lands or deep sandy or gravelly loams are preferred for hop raising. The soil with a high percentage of sand is readilly tillable, while the cultivation of a stiff soil is difficult and expensive. Owing to variations in the rainfall, amount of sunshine, and force of the prevailing winds, land suitable for hop culture in one region would be entirely unsuitable if located in another. Since the roots of the hop plant penetrate the earth for a distance of many feet, a well-drained subsoil is essential. Especial attention must be given to the depth, fertility, drainage, and fineness of the soil. Heavy wet soils are avoided and stiff clayey soils are in general disfavor.

PROPAGATION.

PROPAGATION FROM SEED.

Hop plants may be raised from the seeds, but this method is seldom employed, since by using cuttings strong plants are more easily and quickly secured. Moreover, seedlings have a tendency to vary greatly, both as to the time of maturing the hops and the quality of the product. Yards planted with seedlings usually show little uniformity in the variety of hops produced and in the time of ripening. Seedlings will not produce hops the first year, and only a small yield may be expected the second year.

USE OF CUTTINGS.

The simplest method of growing hop vines is from root cuttings, also called "roots" or "sets." In some localities roots that have been in the nursery for one year are called "sets." The numerous surface runners sent out by the hop plant are removed when the plants are pruned in the spring, and these, cut into pieces each bearing at least two sets of "eyes" or buds, are used to produce new plants.

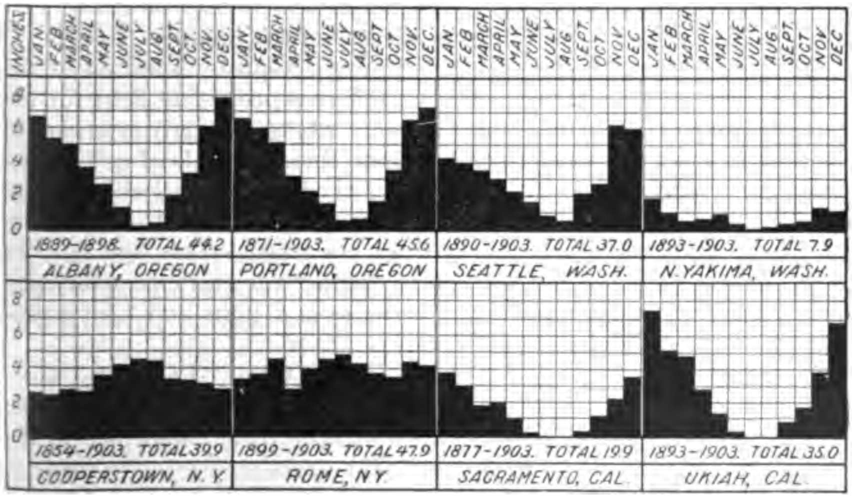

FIG. 2.—Chart showing rainfall in the principal hop-growing regions of the United States. The chart shows the average rainfall during each month in the year for the period of years indicated in the space below. The totals given are average totals for the years indicated.

In some sections of the Pacific coast a crop may be obtained from cuttings planted in the spring, but in general a full crop is not harvested until the second year.

The best cuttings are those taken from young plants, as they are more resistant to disease and should be more productive than those from old plants. All cuttings should be carefully inspected before planting and the diseased or damaged ones rejected.

ORIGINATING NEW VARIETIES.

The important subject of originating new varieties, as well as the no less promising one of improving existing varieties, merits the attention of every hop grower. The plants of every field are more or less variable. Some bear more heavily than others, some are richer in the desirable resins, and some will show other high-grade qualities. New varieties may be sought for among the plants in the nursery when these are grown from seed. After the seedlings have been transplanted to the yards and have matured a crop a careful examination at picking time may show that some have superior qualities. These should be suitably marked and cuttings made therefrom the next season for further selection. There is no good reason why this method if persisted in should not produce valuable new varieties. The favorable results secured with new and improved varieties of corn, wheat, grapes, and other crops may be duplicated in hop culture and suggest lines along which improvement may be made, particularly in regard to bettering the quality of the product.

The opportunity for producing improved sorts by selection of the stocks from which cuttings are taken offers a promising field for the progressive hop grower. Many growers who give much attention to improving the fertility of their fields and their methods of cultivation take their cuttings for planting from the nearest available supply without any consideration of the productiveness and other qualities of the plants from which the cuttings are taken. This has resulted in many yards in the loss of certain distinct varietal characteristics, and in almost every field mixed varieties and light and heavy producers occur indiscriminately.

A decided improvement in quality should follow the careful selection of cuttings with reference to productiveness, uniformity, disease resistance, and general adaptability to the cultural conditions in the region where they are to be grown. The selection should be made at picking time, when the hills containing plants of superior quality and productiveness can be staked, so that cuttings may be taken therefrom the next season.

PLANTING AND CULTIVATING.

TIME TO PLANT.

The time at which planting is done depends very largely on the local conditions existing where the crop is grown, but in general the best results are obtained by planting as soon as the soil can be worked into a fine mellow condition. In California planting should be done in January or February, although in some seasons planting as late as the 1st of May has yielded good results. In Oregon and Washington hops are planted in March or April, and in New York successful plantings have been made in April in favorable seasons.

SETTING THE ROOTS.

In California practically all new hops are now set out in rows at a distance of 6½ to 7 feet apart each way. When set 6½ feet apart, there will be 1,031 hills to the acre and 42¼ square feet of soil to the plants of each hill; when set 7 feet apart, there will be 898 hills per acre and 49 square feet of soil to the plants of each hill. In Oregon and Washington, where two horses are used in cultivating, the distance between rows is usually 8 feet, requiring but 680 plants per acre.

The methods of cultivating the hop yards necessitate straight rows. Three and often four cuttings are set in each hill. Differences of opinion and practice exist, and the number which it is advisable to set is in a measure dependent on the system of training employed and the cost of roots. The setting of a fourth root is a measure of precaution against the possibility of loss by rotting or injury of one or more of the cuttings after they are set out.

A good method of setting the roots is first to mark the center of each hill by a small stake to which are attached the strings on which the vines are to run; then, about this stake to make three holes forming roughly the apices of an equilateral triangle with a side measuring about 6 inches. These holes are usually made with a dibble, but in very compact soils an iron crowbar is frequently used. The roots are then placed singly in these holes in an upright position, with the buds pointing upward, at such a depth that they will be from 1 inch (in Oregon) to 3 inches (in California) below the surface of the soil, which is then slightly tamped about them. Another method is to make a hole with a spade at the location of the hill and to plant therein from one to four roots, according to their strength. This is the more rapid method but is less desirable, since the roots are crowded together and are more subject to decay.

The price of roots is quite variable, ranging from $1 per 1,000 when they are plentiful to from $8 to $10 per 1,000 in years when they are scarce.

CULTIVATING.

Thorough cultivation is important and should begin early and continue until the plants are well armed out. This is necessary not only to keep down the weeds, but also to prevent the topsoil from forming a crust and becoming hard, for when it is in this state the moisture of the undersoil rises to the surface and evaporates quickly. The frequent stirring of the topsoil to a depth of 2 or 3 inches will produce a layer of finely divided soil which conserves the moisture near the surface, where it is more readily reached by the young feeding roots which develop at about the time the hops go into the burr. If these small feeding roots are destroyed or seriously injured by late cultivation, growth will be checked and early ripening favored.

Careful growers agree that the young buds do not set so well if the feeding roots are seriously disturbed, and that the crop is shorter in consequence. Nevertheless, if the soil is becoming hard and the moisture is readily evaporating, it may be best, at least in dry sections, to cultivate and depend upon a second growth of the feeding roots for the proper maturing of the crop. The existing soil conditions must determine the advisability of cultivating after the appearance of the feeding roots.

PRUNING.

By the process of pruning, the excess shoots from the rootstock are removed and the formation of fewer but at the same time stronger vines is favored. The rootstock itself also is reduced to an acceptable form and suitable depth below the surface of the soil, and the formation of undesirable runners is retarded or suppressed. The working over of the ground incident to pruning also is an important part of cultivation.

Within certain limits determined by local conditions, the length of the growing period and the time of ripening may be influenced by the earliness or lateness of pruning. The general practice is to prune early in the spring, the exact time being determined by the season and the locality.

A common practice is to draw four or five furrows with a small plow on each side of the row, turning the earth away from the hills. The yard is then cross-plowed in a similar manner, leaving each hill a small undisturbed square. The earth is then hoed and grubbed away from the roots, and the superfluous roots and runners, together with an inch or two of the top of the root crown, are cut off with sharp knife. After pruning, the hoe is used to pull the soil back upon the hill, covering the rootstock to a depth of 2 or 3 inches. Too much pruning by this method causes disease, and frequently uneven pruning causes the late coming out of the overpruned vines.

Another method which offers several advantages over the former is to prepare the ground by plowing as before, using a coulter on the plow in drawing the last two furrows. The hill is not dug into, but instead a sharp spade is used, with which each side of the hill is cut down on a slant from top to bottom, leaving the hill about 4 inches square at the top and 12 to 14 inches square at the bottom. With this method baking of the soil over the hill is avoided and the new shoots come through much more easily. The pruning is more even and the rootstock suffers less from wounds and bruises than by the former method.

TRELLISES.

Except in the hop-growing regions of New York, the use of hop poles (fig. 3) has been largely discontinued in those regions where there is a scarcity of available timber, and even in heavily wooded sections many growers have dispensed with them. This is not due to the labor and expense of handling alone, but experience has proved that the advantages of growing hops on strings so far surpass the growth on poles that it is only a question of time when poles will be almost entirely abandoned. The hops are health-r on strings, more successfully sprayed, mature earlier, are usually cher and brighter, arm out lower, and are not so leafy; they do not ind-whip so readily, can be picked cleaner, and are much more sily torn down for picking. Also the hops can be picked without itting the vine, a practice which is harmful, since it prevents the turn of materials from the vine to the root of the hop, and, by using a loss of food reserves to the stock, produces a weakening fect on the succeeding crop.

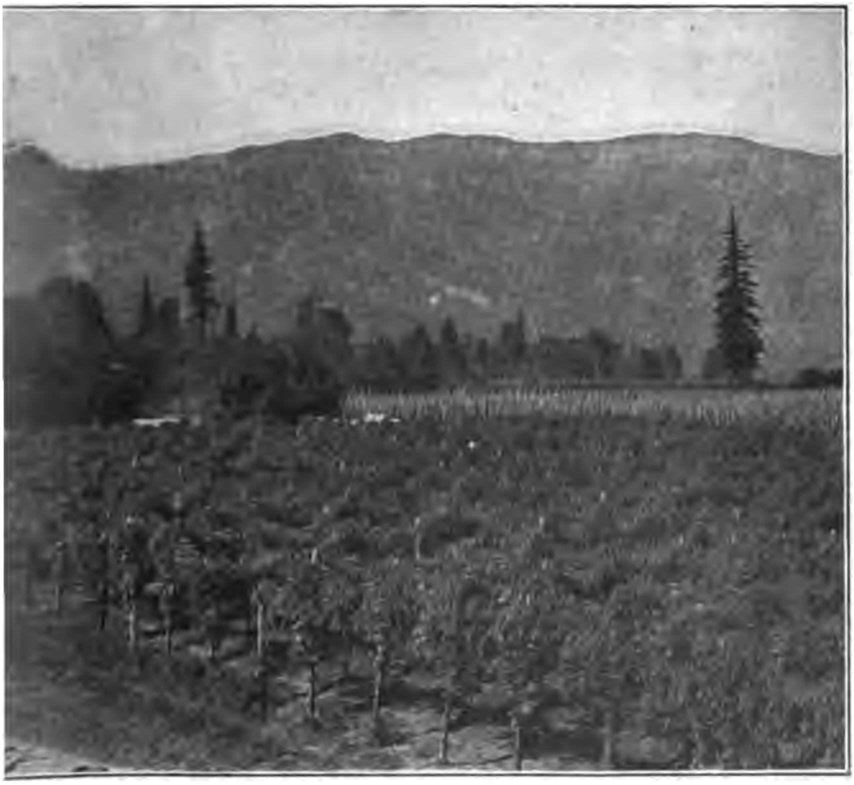

FIG. 3.—A field of hops growing on poles.

For a permanent yard some form of the wire trellis shown in fig. 4 will doubtless give the best satisfaction in most sections. In sections where timber is plentiful the first cost somewhat exceeds that of the pole system, but the saving in labor, the advantages afforded in spraying, and the heavier crop obtained by this method have uniformly reduced the cost of hop production where poles have been replaced by wire trellises.

The wire trellis is constructed in almost numberless ways, but these may all be included in two general classes or types—the high and

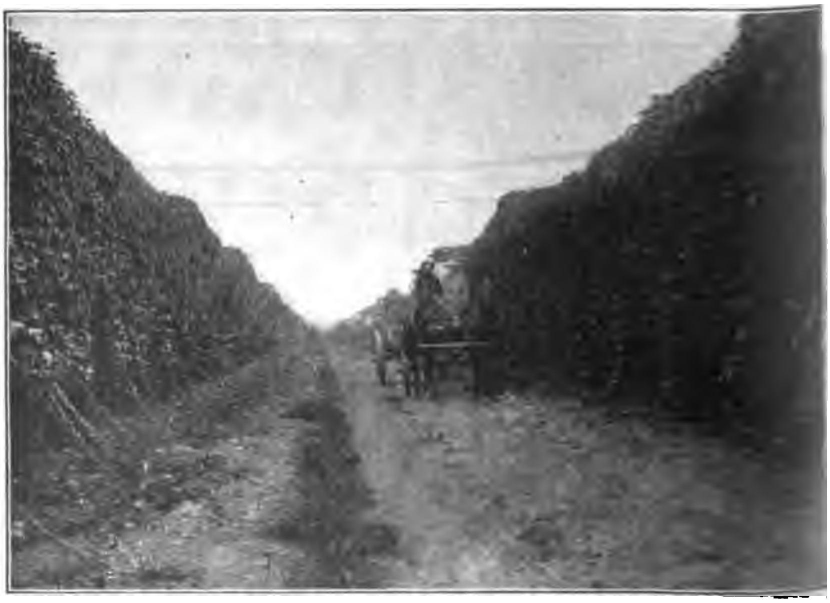

FIG. 4.—Roadway between fields of hops, showing a fine growth of vines on high wire trellis

the low trellis. The high trellis is most widely used, and upon it t greatest improvements have been made.

THE HIGH TRELLIS.

The high-wire system consists essentially in setting posts at ev sixth or seventh hill throughout the yard. Over the tops of th posts wires are stretched across the yard each way at right an (fig. 5). Posts are also set at the ends of the intervening rows tween which wires are stretched over the rows. These wires fastened to the cross wires, and strings led up to them from the h support the vines.

For posts, which may be either split or sawed timber, suitable ha wood or creosoted pine is used. These posts are usually from 4 6 inches in diameter and 20 feet long. The end posts should not less than 6 by 6 inches, but somewhat lighter timbers may be used interior supports. The posts are set from 1½ to 2 feet in the ground, the interior ones upright, those in the outside rows inclining somewhat outward. At a distance of about 14 feet outward from the foot of each end post an anchor, made of a piece of timber 6 by 6 inches and 4 feet long, is buried at a depth of 4 to 6 feet, according to the tenacity of the soil. Anchors made from locust are preferred, because of the lasting quality of the wood. A strong guy wire is run from the top of the post and fastened securely to the anchor; or the string wire may be run over the top of the end post and down to the anchor.

To permit easier access to the field, posts are frequently placed at the ends of alternate rows only. The string wires of the rows without end posts are then either run over the end cross wire to the ground and anchored or they are forked and fastened to the end posts on each side. For the principal or cross wires running across the field the shortest way and fastened on the top of each post with heavy staples, No. 0 annealed iron wire is used. These wires are keyed up taut and fastened securely to anchors at each end. For the other or string wires Nos. 6 to 8 annealed iron wires may be used. On the latest improved or drop-wire trellis shown in figure 5 the string wires are held in place underneath the cross wire by short S-hooks made of No. 2 wire. At picking time the string wires may be unhooked and let down, thus bringing the hops within easy reach of the pickers. This trellis can usually be erected at a cost of from $80 to $90 an acre, and twine for supporting the vines necessitates an annual expenditure of about $5 an acre.

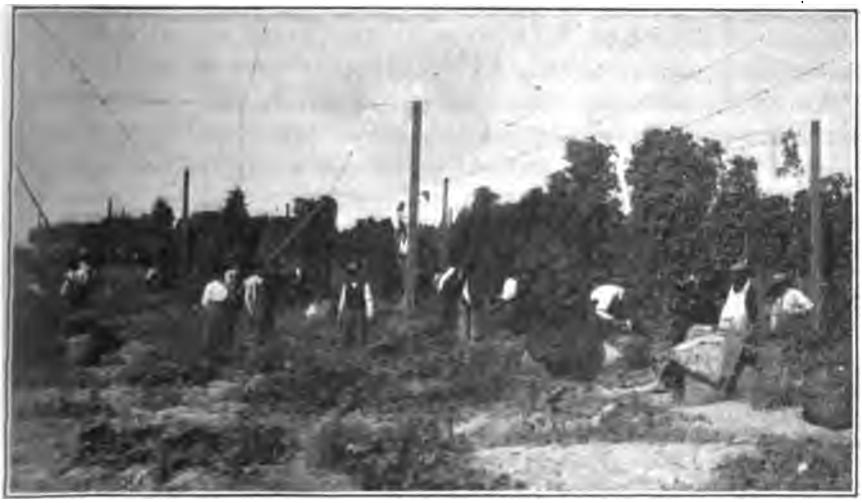

FIG. 5.—Field of hops showing details of the drop-wire trellis and method of picking.

In another successful form of this system an additional wire, known as the "breast wire," runs over each row below and parallel to the string wire at a height of about 6 feet from the ground. The strings rise vertically to the breast wire; then they are taken on the slope to the top or string wire, which is above the next row of hills. The angle of the sloping string is affected by the distance between the rows as well as by the height of the breast wire. The steeper the slope the better the growth of the vine. At half slope hand training will be necessary, but a flat slope gives better exposure to the sun and increases productiveness.

THE LOW TRELLIS.

The low form of trellis appears in several modifications. In one form poles about 8 feet long are set at each hill. Over the tops of the poles wires are run the full length of the yard each way, crossing at right angles. The vines are led up the poles or stakes and then find support on the wires. In many cases stout twine is used instead of wire, and in some instances the poles are set at every third hill.

Except in situations swept by strong winds, the high trellis is much more satisfactory. It is a permanent structure which gives easy access for teams to every part of the yard. The hops receive more uniform exposure to light and air and are in consequence better developed. Cultivation is not interfered with by drooping arms so much as in the low-trellis system. The hops can be readily sprayed even at picking time, when the worst attacks of lice are likely to occur. Since a hop vine will not follow a horizontal support, when it reaches the wire or string of the low trellis it must be trained by hand, thus materially increasing the cost of cultivation.

SYSTEMS OF TRAINING.

STRINGING.

Where the high-wire trellis is employed, cotton cord is used to form supports for the vines until they reach the wires. The string consists of two portions knotted together; one, a cord 4 feet long having a breaking strain of 80 pounds, is attached to the wire, and the other, a cord 15 feet long having a breaking strain of 20 pounds is tied to a small stake set in the hill. The smaller cord is strong enough to support the vine until it reaches the heavier cord at the top. Good hemp is often used for the top string instead of cotton cord. The string may be fastened to the wires by means of a special knot-tying device attached to the end of a long pole, but the plan pursued in the trellis fields where the drop-wire system is used is simply to unhook and lower the string wire (fig. 5), to which the strings may then be attached by the workmen while standing on the ground. The strings, which are cut to the desired lengths are knotted in advance, are fastened to the wires about 20 inches from a point on the wire directly over the center of each hill. Usually but two strings are used for each hill, and when all have been fastened to the wire it is again hooked up in place on the cross wires.

Another plan is to use a "trellis wagon," on which is a platform of such elevation that the workmen thereon may move about freely beneath the wires while attaching the strings. The wagon follows the string wire across the field. Two or three men on the wagon will put the strings on two wires as fast as the team can walk. Four men following the wagon can fasten the ends of the strings to small stakes set in the ground at each hill.

In the pole yards of New York a loop in one end of the string is passed over the top of the pole by means of a forked stick, and then drawn taut. The remaining end is then fastened to the adjacent pole in the next row about 5 feet from the ground. Frequently another string is fastened from pole to pole at the same distance above ground.

TRAINING.

When the young vines are about 2 feet long training is begun. Usually the four runners most closely approaching in length the average of the field are selected from each hill and the remainder are cut off. In case of an uneven stand it may be well to cut off the whole field and wait for the second set of runners. However, vines which may be inferior at first sometimes develop a vigorous growth after they have reached a length of 4 or 5 feet. As a general rule, in all light producing sections it is advisable to train the first runners; in heavy producing sections the second runners should be chosen. Two runners are usually trained to each string, care being taken to twine them from left to right about the string.

In the New York yards many farmers train seven vines up each pole, three for the long string and two each for the other string and the pole.

PICKING.

TIME TO PICK.

The time when hops should be picked varies with the locality, the season, and the variety cultivated. When the acreage is large there is a tendency to start picking before the crop is fully mature, as otherwise a portion may be lost through becoming overripe. Also a great consideration with many growers is the early securing of pickers. To this end it is customary in some sections to plant an early-bearing variety, e. g., Fuggles, which ripens from a week to ten days earlier than the other standard varieties and enables the grower to begin picking so much earlier.

A second consideration is the capacity of the drying plant to handle the crop as fast as harvested. If the acreage is large and the crop heavy, the facilities for handling and drying the hops will be taxed to their utmost, and if more hops are picked than can be put upon the kilns and dried without delay they undergo heating and are thereby seriously damaged in quality or lost entirely. Because of inadequate facilities, therefore, growers frequently begin picking before the hops are ripe and continue picking after they have passed what is recognized as the most suitable stage for harvesting.

A third consideration, which is recognized by all progressive growers, is the effect of the picking time upon the quality of the product. The development of the essential oil, the desirable soft resins, and other valuable constituents reaches its height about the time the hops become fully ripe, in which condition they are generally regarded as possessing the finest flavor.

From the standpoint of the consumer the time of picking is a matter of great interest, and it should be also to every grower, as a much higher quality of hops would result from picking at the proper time. However, for reasons previously mentioned it is often very difficult to secure pickers when the crop is just ripe. In addition to the difficulties just mentioned, the several parts of the field rarely ripen exactly together; often when a field is practically level slight variation in quality of soil or moisture content will result in unevenness in ripening, and while it is customary in picking to work around and through the field, choosing first the ripe portions, it is rarely possible to pick all of the crop at the most desirable degree of ripeness.

While growers recognize in a general way the importance of a proper picking time, the disadvantages arising from a disregard of this time are not appreciated by all. There are several important objections to improperly picked hops which reduce their market value.

DISADVANTAGES OF UNRIPE HOPS.

Unripe hops contain more water in proportion to their weight of dry substance than those which are ripe; consequently in drying the "conversion" is not so high; that is, the ratio of the dry hops to the weight of green hops put upon the kiln is smaller when the hops are unripe. Unripe hops are also more difficult to dry on the kiln, probably because of their higher water content and tendency to pack together as soon as wilted, and also they do not keep so well when stored. Since the lupulin in unripe hops has not reached its full development, there is an absolute loss of weight by picking in this condition. The aroma is not so well developed and the amount of resins is smaller in the unripe hop. Not only is there a loss of weight due to too early picking, but practically all of the desirable qualities upon which the value of the hop depends are also in large measure diminished.

TESTS FOR RIPE HOPS.

By means of certain practical tests the degrees of ripeness and suitability for picking of the hop may be readily determined. (1) The strobiles or cones, which are bright green in color in the vegetative state, change gradually to a bright yellowish green as they approach ripeness. This is not always an exact test, as the color is somewhat dependent upon the soil and some other factors. Some hops have a greenish color when they are ripe. Sometimes in fields infested by the wild morning-glory a yellowing of the cones may occur, which is not due to ripening, but rather indicates an unhealthy condition in the plants themselves. (2) Immature hops are soft and pliable and have no resiliency or elasticity. As they ripen, however, they become more and more elastic, and if slightly compressed between the fingers will, on being released, assume at once their original condition. (3) When hops have a crisp feeling and give forth a rustling sound when crushed in the hand they are regarded as ripe. (4) The so-called seeds of the hop are in reality fruits, the seed being covered by a closely adhering pericarp, which, when the hop is ripe, takes on a dark purple color. At this time also the seeds fill out and become hard. (5) The bracts at the point of the cone close as ripening progresses, and the cones themselves feel sticky or greasy. (6) Immature hops have little odor aside from the natural green or plant odor until they are near ripeness, when the characteristic lupulin odor becomes very marked. (7) As the hops approach maturity the upper foliage leaves change from light green to dark green, while those on the lower part of the plant turn yellowish and drop off.

CURING.

THE OBJECT OF CURING.

The primary object of curing hops is to reduce rapidly their moisture content to such a degree that they may be safely stored and their properties preserved. Hops must be dried soon after their removal from the vines, as otherwise they undergo a process of oxidation or heating which seriously injures their appearance as well as their aroma and other valuable qualities. According to the variety and the degree of ripeness when gathered, freshly picked hops contain 65 to 75 per cent of moisture, but when in a dry state fit for storage or marketing they should contain only from 10 to 14 per cent of moisture. Increased knowledge of the constituents and properties of hops has extended the idea of curing to include the production of a hop which not only has a fine physical appearance, but which also contains the maximum amount of the desirable principles upon which its intrinsic value is based. The most important of these principles are the tannin, found mostly in the bracts of the cone, the soft resins, the volatile oil, and the bitter principles which occur chiefly in the lupulin. Curing is all too frequently conducted with regard to the physical appearance alone, and the methods employed often injure the quality of the hop through their harmful effects on the oil, lupulin, etc.

THE THEORY OF DRYING.

The removal of moisture from hops constitutes drying. In the atmosphere this is ordinarily accomplished by evaporation, a process which is dependent upon the ability of the air surrounding the drying hops to carry off the surface moisture in a vaporized state. The amount of moisture in the form of vapor which the air can take up depends upon its dryness, since there is a maximum amount of vapor which the air can contain. When this maximum is reached the air is saturated or at the dew point and will take up no more moisture. In order that drying may proceed the saturated air must be constantly replaced by drier air, and a brisk artificial circulation therefore hastens the process.

The ability of the air to take up moisture varies with its temperature, and an immediate effect of heat on the atmosphere is to increase its capacity to absorb aqueous vapor; for example, it has been determined that the moisture in 10,000 cubic feet of air saturated with aqueous vapor at 62° F. weighs 8.81 pounds. On raising the temperature of the air to 82° F. the 10,000 cubic feet of air can take up 7.86 pounds additional moisture; and by increasing the temperature to 122° F. 42.61 pounds additional can be carried. If, however, the air at 62° F. is only half saturated, 10,000 cubic feet will contain but 4.4 pounds of moisture; then raising the temperature to 82° F. will enable the 10,000 cubic feet to take up 12.27 pounds additional, and increasing the temperature to 122° F. admits of 47 pounds additional being carried.

The volume of air necessary to effect drying within a given time is dependent upon its temperature. Because of its greater moisture-carrying power a small volume of air at a high temperature will absorb and carry away an amount of vapor the removal of which would require a relatively large volume of air at a low temperature. If half-saturated air heated to 162° F. in passing over a moist surface at the rate of 10,000 cubic feet per minute removed therefrom in that time 130 pounds of moisture, it would require about twenty-three minutes to carry away 3,000 pounds of moisture. If, now, the same air were cooled to 82° F., 10,000 cubic feet per minute could remove about 12 pounds, and nearly four and one-half hours would be required to remove 3,000 pounds of moisture. To carry away the moisture in the same time as the air at 162° F. a volume of about 108,000 cubic feet per minute would be required.

In practice it has been found that the air driven through a mass of hops does not become fully saturated with moisture, and only during the early stages of drying does the amount of moisture actually removed approach the quantity which would be removed if the air carried its full capacity. At the temperature commonly used in drying, therefore, a much larger volume of air must be provided to remove a given amount of moisture than apparently would be required from a consideration of the figures given.

A certain degree of heat is always advantageous in drying hops because of the conditions under which the moisture in them occurs. A part of this moisture is free water and is the first to be exhausted in drying. The rest forms a part of the sap and tissues, and its removal affects the physical condition of the drying hops. Heat, by raising the temperature of the tissues and cell sap, promotes the passage of water to the surface, where it may be removed by vaporization. An artificial supply of heat is also necessary to replace that lost from the hops by the process of vaporization; otherwise the temperature of the moisture held in the cells will remain so low that it will not move readily to the surface and drying will be retarded.

In drying hops good results, however, are not obtained merely by supplying a high degree of heat below the floor of the kiln. When hops are piled on the floor at a depth of from 14 to 30 inches, they form an extremely poor conductor of heat. Not only are the hops themselves a poor conductor, but the air heavy with aqueous vapor filling the spaces between the hops offers much resistance to the transfer of heat. It thus happens that when heat is applied to the floor of hops the moisture of the lower layers is driven off, the air in contact with them becomes saturated, and, rising quickly, comes into contact with cooler layers. Here the saturated air is cooled, with the result that its moisture is condensed and deposited on the upper layers of hops until they become wet and soaked. The continuous application of heat thus results in the lower layers becoming dried out and overheated, while the heat gradually working upward through the wet layers of hops subjects them to a harmful steaming process. The difficulty is frequently increased by the practice of turning the hops, as in this way the overdried layers from the bottom are brought to the surface and again steamed and dried.

It is evident that a rapid and continuous removal of moisture is desirable, and to accomplish this draft and ventilation are necessary. A strong draft is necessary to insure a rapid movement of the heated air through the layers of hops, since by rapid replacement of the air in contact with the moist hops time is not afforded to approximate the point of saturation; hence the air can undergo quite a degree of cooling in the upper layers without reaching the dew point and depositing its moisture. Top ventilation is necessary to remove the vapor-laden atmosphere from above the hops; otherwise the point of saturation would be quickly reached and the moisture deposited on the sides of the kiln and the hops themselves. Ventilation is closely connected with draft and is dependent upon it. Conditions which secure good natural draft usually provide sufficient ventilation.

Draft and ventilation, as well as drying itself, are very dependent on the temperature and humidity of the atmosphere. Draft or a definite upward movement of the air in a kiln occurs when heat is applied at its base. The cold air outside the kiln being heavier than the warm air within constantly tends to establish an equilibrium of pressure by flowing down to the base of the heated kiln. As a direct consequence the heated air is forced upward, and the cold air taking its place is in turn heated and will follow the same course. A continuous circulation is thus established, its velocity and volume depending on the difference in density of the outside air and the air within the kiln.

The changes of temperature in the external atmosphere have very marked influence on draft. In hop drying it is observed that the best draft is usually secured about 2 or 3 o'clock in the morning. This is about the time when the greatest temperature differences exist between the outside and inside air, with a corresponding difference in pressure resulting in increased draft. This advantage, however, is largely offset by the great increase of humidity in the atmosphere at night. In the daytime when the air temperature is high great difficulty frequently arises in securing a draft without at the same time overheating the hops. Usually a difference of about 50 F. between the temperature under the kiln floor and that over the top of the kiln is necessary in California to cause a sufficient pressure to force the air through the hops. In Oregon a difference of 30° F. is generally sufficient to accomplish the same result, the reason for the difference being that the hops are not laid so deep on the floor and twenty to twenty-four hours are used in drying as against ten to twelve hours in some districts in California. Assuming that a difference in temperature between the atmosphere and the air in the kiln of from 30° to 50° F. is necessary to cause a draft through the hops, it is apparent that the greatest care must be used to avoid damage to the hops through overheating.

Many of the difficulties attendant on the use of natural draft have been overcome by recourse to forced draft. By this means a large volume of air is driven through the hops, instantly setting up a good circulation of air and rapidly carrying off the moisture, so that the hops do not undergo the long sweating and steaming process which is a necessary accompaniment of the use of a natural draft. Drying is possible also at a much lower temperature, and this method presents many other advantages, among which is absolute control of a low, even temperature, giving an increase of soft resins, flavor, aroma, and weight.

NATURE OF THE CURING PROCESS.

When the hops are placed upon the floor of the kiln the cells which compose their tissues are still alive. Proper curing consists in bringing about the death of these cells through the gradual withdrawal of water from them at a moderate temperature. Within each cell are many chemical substances which remain separated so long as the cell is alive, but which are thrown out of solution by the loss of water from the cell and left in a form in which they are very readily soluble. If the removal of water does not proceed steadily, or if the vapors are allowed to settle back, moisture condenses on the hops and is readily reabsorbed and, coming in contact with the readily soluble substances, dissolves them. In this condition these substances cause blackening or discoloration and the hops are injured in other ways.

Death of the cells may be caused without much water loss by sudden exposure to high temperature. In such a case the chemical substances no longer remain separated, but flow together and form new compounds with resultant changes in color, aroma, and other desirable qualities. The cells may sustain a considerable water loss before they are killed, provided the temperature is kept below a certain point (about 110° F.). As soon as the death of the cell occurs and the flowing together of its compounds begins, drying should be forced somewhat more rapidly, in order to reduce the amount of water present as fast as possible, but even in this stage of drying the temperature can probably not long exceed 140° F. without injury to the quality.

PRACTICAL DRYING.

The most important and at the same time the most difficult part of hop production is proper drying. No other factor affects the quality, appearance, and market value as much as the manner in which the hops are handled during the curing process.

In the drying process three factors are of primary importance. These are (1) degree of temperature used; (2) length of time of drying; (3) volume of air passing through the hops. Also, in drying at a very low temperature the humidity of the air is an important factor. Only the first two of the factors mentioned have been generally recognized, and the high temperatures used at present are the result of shortening the time of drying. It is possible to diminish the temperature materially without lengthening the time of drying by forcing through the hops a large volume of air at low temperature.

The first care is to properly lay the hops on the drying floor. They should be spread out evenly and loosely to a depth of 14 to 24 inches, depending upon the ripeness. In an uneven floor the heat will break through first in the thinner places, which quickly become dry, while the thicker portions remain damp. If the hops are trampled or otherwise packed together on the floor the heat will not readily pass through them and drying is rendered uneven. Some practical growers set a stout wire screen of about 5-inch mesh at the desired height above the floor and the hops emptied from the bags upon this fall lightly and evenly to the floor beneath. The top is then carefully leveled with a rake.

As soon as the floor is laid the fires are started and the heat is gradually brought up to the desired point. In from three to five hours the hops will have become heated throughout and sufficient moisture will be driven off so that the hot air will readily pass through them. Until this point is reached the temperature must be closely watched, as too rapid firing at first will cause the under layers to scorch. In sections where drying is accomplished in ten to twelve hours a very common practice is to turn the hops with a wooden barley fork when the lower layers are dry enough to rattle when stirred. This should be done only when absolutely necessary, as turning breaks and shatters the hops and a portion of the lupulin is lost. Since the hops can not be turned evenly this practice hinders uniform drying.

During the course of drying sufficient ventilation must be provided to carry off the moisture without at the same time cooling the sides of the kiln and the top of the hops enough to cause the moisture to be deposited. Warming the air and the sides of the kiln above the hops materially aids drying. In the more northerly hop regions the most successful kilns are ceiled to the top, thus better retaining the heat.

The almost universal failure to recognize the harmful effects of high temperature in drying has caused wide diversity in practice. Temperatures of over 200° F. are not uncommon. That this is far too high has been shown by experiments made in the field with hops cured on various kilns at different temperatures. Aside from ruining the flavor by overdrying or scorching, there is a distinct loss of valuable essential principles by drying at high temperatures. The volatile oil, to which the aroma is largely due, is partially evaporated and the lupulin is rendered inferior, since the amount of the desirable soft resins becomes proportionately less as the drying temperature is increased. The best temperature for drying is yet to be determined, but every consideration indicates that it should be much lower than that commonly employed, probably between 100° and 140° F. Practical experience has shown that good drying may be accomplished with a temperature of 110° F., and the general trend of opinion is toward the use of the lower temperatures in drying. No fixed temperature, however, can be assigned as the most suitable for drying, because a degree of heat which at one stage of drying would probably be detrimental, at another would have no injurious effects. In taking the temperature care should be used to see that the thermometer is placed where the heat on the hops is greatest. This point has been found to be just below the drying floor. During the first part of the drying a thermometer below the cloth of the drying floor will register higher than one placed on the floor at the bottom of the hops, and one placed just above the hops will register 30° to 40° lower until drying is perhaps half finished or until the heat breaks through the hops. During this period of drying the heat is concentrated on the lower layers of hops, and here the greatest care is necessary to avoid injury. When the heat begins to break through the hops the upper thermometer will show a rapid rise of temperature, while the one below the floor will show a decline. From this point on to the end of the drying the two thermometers will show approximately the same degree of temperature.

As already stated, hops are frequently cured in from ten to twelve hours, but, other conditions being equal, a higher temperature must be used than when the time is extended to eighteen or twenty hours. The advantages of slower curing or curing at a lower temperature should be universally understood by hop growers. Even a moderately high temperature continued too long will damage the quality of the hops, the same as too high a temperature. In order that the hops may be dried at as low a temperature as can be made to do the work a strong draft is necessary during the drying to continuously carry off the moisture from the hops. There is no doubt that the principle of the air-blast kiln at present most satisfactorily meets these requirements.

No definite rule has yet been given for determining when hops are sufficiently dried. The condition in which they may be safely removed from the kilns can at present be told only by experience. The amount of drying will vary from day to day, being dependent upon weather conditions and the ripeness of the hops. In general, drying should continue until nearly all the stems or cores are shriveled, but are still soft and pliable. If overdried, the stems crumble and break readily, and the lupulin loses its bright, clear yellow appearance and turns brown. If hops are taken off the kilns slack or underdried they are very apt to heat, which turns the lupulin brown, and to develop a sour musty smell which makes them undesirable. If they are high dried or overdried they will break badly and become chaffy, and they also develop a burnt, peanutty odor.

The thin leaflike portions of the hop usually become dry enough to break readily by the time the stems are dried sufficiently to make safe the removal of the hops from the kiln. This condition may be remedied by closing the ventilators half an hour before the drying is finished. This will also somewhat restore hops that have been overdried, as the further escape of moisture from the kilns is prevented, which then tends to equalize in the hops, soon softening and toughening them. Many careful dryers make a regular practice of gradually closing the ventilators as drying proceeds, and finish the kiln with them tightly closed. The same result may be indifferently accomplished by opening all the doors of the kiln and letting the hops cool for about an hour, as by this process they absorb moisture from the air and become less brittle.

SULPHURING.

The practice of sulphuring hops, which is now almost universal, is a response to the demands of the market chiefly for the pale yellowish green grades. The use of sulphur not only gives the hops the desirable yellow color, but makes them more uniform in appearance, thus increasing their salability. Many dealers are guided more by color than by other qualities, and such dealers have been known to rate unsulphured hops as inferior, while sulphured hops from the same field were classed as choice.

The use of sulphur improves the color by bleaching, injures the micro-organisms present, thus probably improving the keeping quality, and, according to a widespread belief, accelerates the drying. The sulphur is usually burned beneath the kiln floor at the commencement of drying. The usual practice is to use from 2 to 6 pounds of sulphur for each 100 pounds of undried hops. The action of the sulphur is most energetic while the hops are yet fresh and damp. Only refined sulphur of guaranteed purity should be used, as the crude sort usually contains impurities which may injure the quality of the hops. The best results are secured with what is known commercially as rock sulphur. Roll sulphur differs from this only in the form in which it is cast and has no greater bleaching power.

TYPES OF KILNS.

With respect to construction, there are many kinds of kilns. Whatever kind of structure is used for drying hops certain features are essential, and these may be comprehended in the description of a typical kiln. As regards methods of operation in the United States two general types must be recognized. In the stove kiln the hops are heated by a stove or furnace placed under the floor; in the air-blast kiln a current of heated air from the outside is forced in by a fan.

The Stove Kiln.

This type of hop drier consists essentially of a furnace room heated by a large stove or furnace and a drying room immediately overhead, into which the heated air from the furnace passes through cracks in the floor. The stove may be situated in the center of the furnace room, but is commonly placed at one side and so arranged that the firing can be done from the outside. A very successful type of kiln is shown in figures 6, 7, 8, and 9. This combines the features of the simple furnace room with those of a style of kiln used on the Pacific coast and known as the "double-hopper" kiln. The building is a well-sided frame 36 feet square and measures 32 feet to the plate, from which the four-sided roof is carried up at one-half or two-thirds pitch. At the top an opening 8 feet square is left, over which is built the ventilator or cupola to a height of 12 feet. Two, or sometimes four, shutters, hinged to the sides of the cupola at the top, are fitted with ropes and pulleys, by means of which they may be opened and closed. Six feet below the plate, or 26 feet from the ground, are placed the joists which support the drying floor, which is composed of slats 1 to 2 inches wide carefully spaced at the thickness of one slat apart (fig. 7). Over the slats is

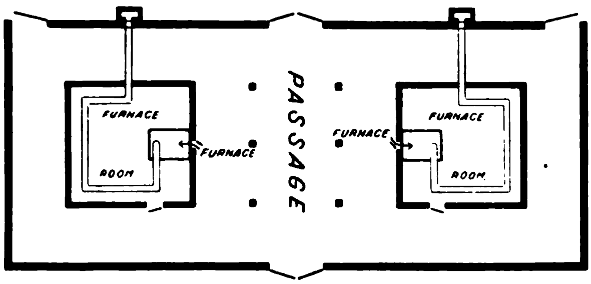

FIG. 6.- Ground-floor plan of stove kiln.

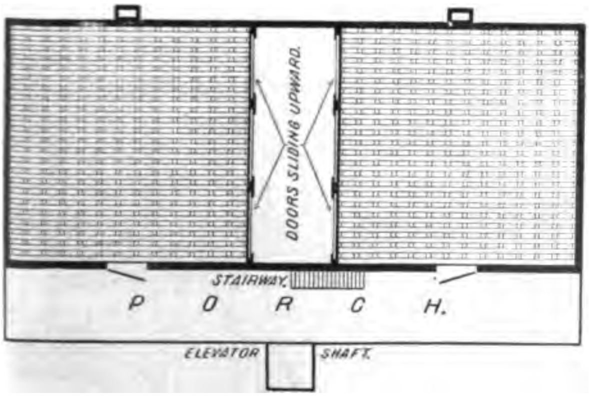

FIG. 7.—Plan of second or drying floor of stove kiln.

stretched a kiln cloth or carpet of 8 to 10 ounce jute, similar in quality to the ordinary barley sack. From the drying floor to the plate the inner wall of the kiln is ceiled in order to retain the heat. In humid regions the best results are secured when the ceiling is carried up on the rafters nearly to the top of the roof. In the center of the room below the drying floor is a second inclosure 18 feet square, made of 2 by 4 inch studding, 10 feet high, and lathed and plastered on the outside to within 10 inches of the floor, leaving next the ground an open space for the admission of air. The draft is largely controlled by means of large doors opening to the outside from the main room. In the type of kiln without the hopper air is admitted through openings in the outside walls close to the ground. These draft openings are provided with shutters which in case of a strong wind are closed on the windward side to prevent uneven drying.

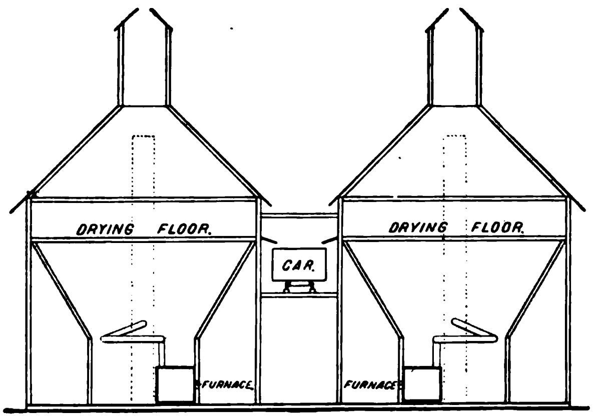

FIG. 8.—Sectional elevation of stove kiln.

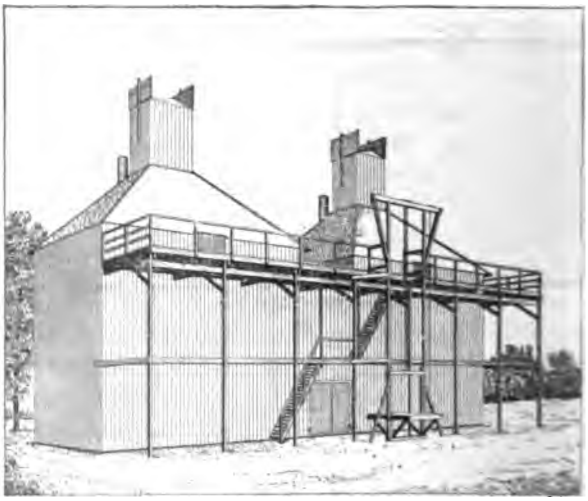

FIG. 9.—Perspective of stove kiln the plans of which are shown in figures 6, 7, and 8.

From the top of the studding used in making the wall of the inner inclosure, timbers run on a slant to the outside walls, which they join just below the drying floor. These timbers are likewise lathed and plastered, forming as it were a huge hopper below the drying floor (fig. 8). The furnace is set in one side of this inner room, and the large pipe therefrom makes a circuit of the hopper at about 10 feet from the ground and is then led to th chimney outside. This kiln may be single or double, as shown in figures 6, 7, and 8. The size may be reduced to suit the needs of the user, and brick or stone may sometimes be used with advantage in its construction. The drying floor, however, should never be less than 20 feet above the ground, on account of the danger of scorching the hops.

The superior advantages claimed for this kiln are the even distribution of the heated air to the drying floor, the strong draft induced by causing all the air to pass in through the small furnace room where it is highly heated, and in the distance of the drying floor from the furnace, whereby the danger of scorching the hops by direct radiation is largely diminished. In this kiln, also, the objections to the real hopper form are largely overcome, since the lower portion of the woodwork does not come so close to the stove as to be in danger of catching fire.

On a level with the drying floor at one side of the kiln a platform is constructed, from which the green hops are transferred to the drying floor. When possible the kiln is erected on sloping ground, so that the hops may be unloaded thereon from wagons, which approach the kiln on a driveway formed by a slight embankment. Inclined wooden driveways, as shown in figure 14, are sometimes used, but the more common practice is to bring the hops from wagons on the ground to the platform by means of an elevator (fig. 9).

At one side of the drying floor doors sliding vertically permit the hops to be readily shoved off into the hop car, which is brought alongside the kiln with its top just below the level of the floor (fig. 8).

The "double-hopper" kiln has failed to realize the advantages hoped for on its introduction some years ago. It is not only very liable to destruction by fire, but the lower hopper limits too much the air space below the hops and does not give the necessary draft at the temperatures most suitable for curing.

The Air-blast Kiln.

The desirability of maintaining a strong draft through the hops while drying on the kiln has led to the employment of various artificial means for this purpose. A device for producing a forced draft which has long been used in England, and frequently tried in the United States, but with poor success, is an exhaust fan placed in the ventilating shaft of the kiln. In an improved method of drying with a forced draft which has been used successfully on the Pacific coast during the last few years a blast fan is used to drive the air through the hops from below. The main features of this method are illustrated in the air-blast kilns of the Pacific coast shown in figures 10, 11, 12, and 13.

These kilns, constructed of wood, of corrugated iron, or of concrete blocks, are from 30 to 36 feet square, and for economy and convenience three or more are usually operated in series under a single roof (fig. 13). Two drying floors are provided in each kiln (fig. 12), the first 9 feet from the ground and the second 7 feet above the first. The lower floors are generally made of slats and covered with a kiln cloth in the usual manner (fig. 11), but the upper floor is made of removable wire-covered sections. The distance from the ground to the plate is 18 feet and to the comb of the roof 30 feet. A low ventilator, fitted with shutters at the sides, terminates the roof and runs the entire length of the building. The draft in these kilns is produced by a blast fan from 7 to 9 feet in diameter, driven by a steam engine at a rate of speed high enough to produce a slight pressure in the air-tight room below the hops. As soon as the fan is started the pressure is established and the air quickly passes through the hops and escapes at the ventilators in the roof.

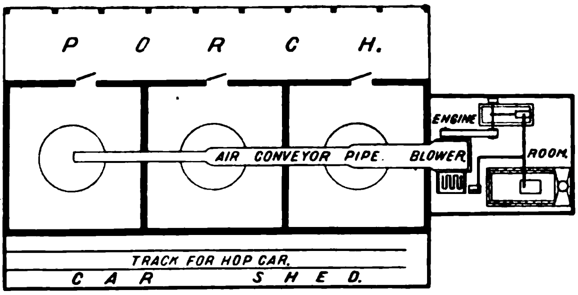

FIG. 10.—First-floor plan of air-blast kiln.

The air intake is outside the kiln, and just before the air enters the fan it is drawn through a sectional steam heater, constructed of 1-inch iron pipes, whereby its temperature may be maintained constant at any desired point. A large pipe, about 5 feet in diameter, conveys the air into the kilns (figs. 10 and 12). At the center of each kiln the air is delivered downward through a curved outlet of the main pipe, 34 inches in diameter, and fitted with a damper by means of which the amount of air admitted to the individual kiln is controlled. Below each outlet pipe is a saucer-shaped concrete-lined depression in the kiln floor which, receiving the inrushing air, deflects and distributes it evenly to the drying hops above.

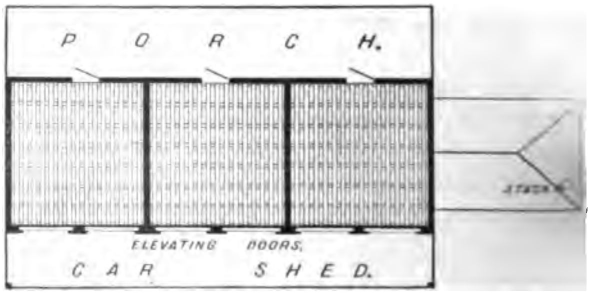

FIG. 11.—Plan of second or drying floor of air-blast kiln.

In a kiln 36 by 36 feet, when the hops are laid 15 inches deep, the green weight is estimated at 7,500 pounds. The conversion of the hops—that is, the number of pounds when green required to produce 1 pound when dry—varies from 3½ to 4. This means, therefore, that in drying a floor of hops of the dimensions just given, from 5,000 to 5,500 pounds of moisture must be carried off. To accomplish this speedily a very large volume of air is necessary if the temperature is kept below the point where the quality of the hops is affected. The superiority of this type of kiln when equipped with a blast fan of sufficient size lies in the possibility of driving through the hops a large volume of air at a low temperature, thus carrying away the moisture and perfectly drying the hops, while overheating, overdrying, and scorching are avoided.

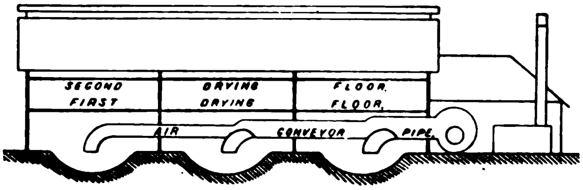

FIG. 12.—Sectional elevation of air-blast kiln.

The ordinary stove kiln may be readily converted into an air-blast kiln by the installation of blowers and devices for heating the air. Figure 14 shows a group of six stove kilns so modified at an expense much less than that necessary for the construction of an entirely new plant.

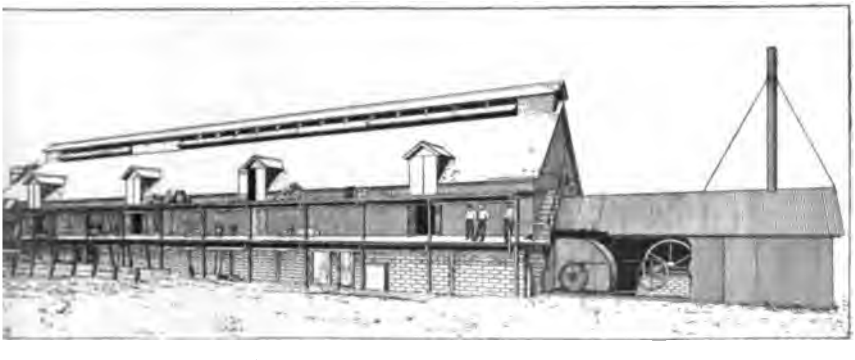

FIG. 13.—Perspective of air-blast kiln the plans of which are shown in figures 10, 11, and 12.

TREATMENT IN THE COOLER.

A very important part of the successful curing of hops is the handling which they receive in the cooling or storage room. The building used for this purpose (fig. 15) is now generally detached from the drying kiln and placed at a distance of 100 to 200 feet as safeguard against fire. Figure 16 shows a sectional elevation of cooling house with the two storage floors above the baling floor.

If necessary the lower floor may also be used for storage, but this necessitates elevating the hops to the second floor for baling. The building should be of tight construction, especially in humid regions

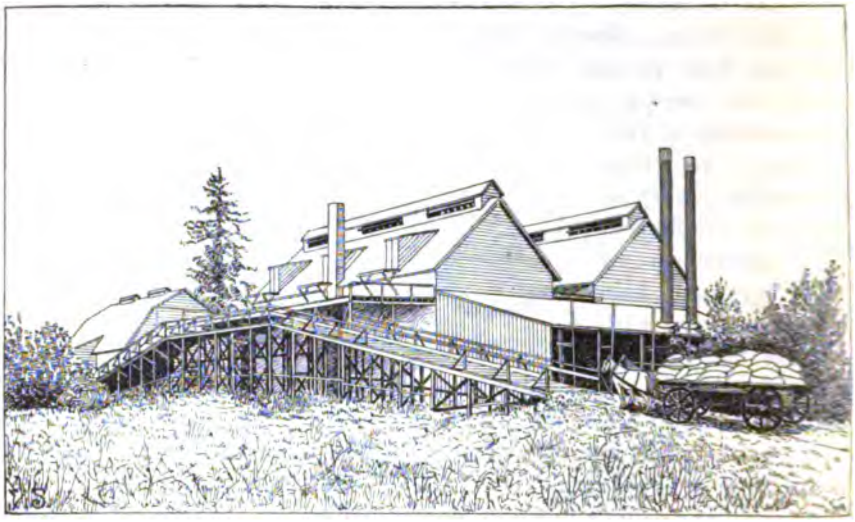

FIG. 14—Group of six stove kilns converted into an air-blast plant.

to prevent the loose hops from absorbing too much moisture fro the air.

The kiln is connected with the cooler by an elevated tramwa

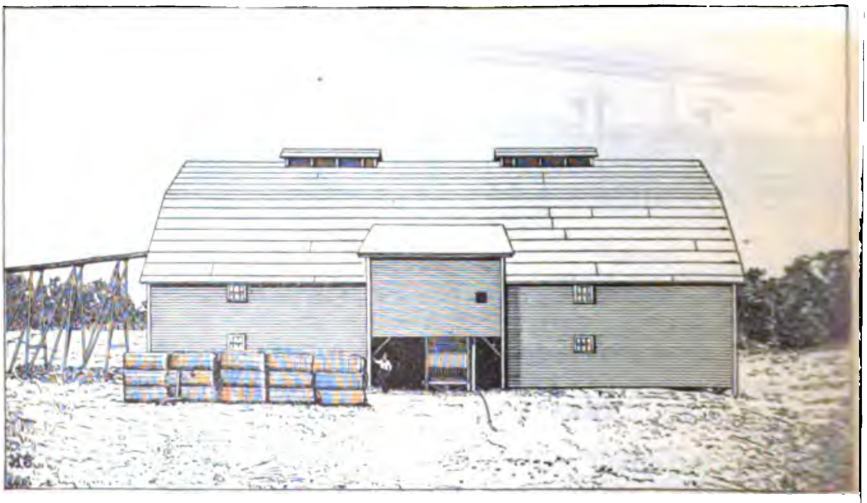

FIG. 15.—Elevation of cooling house, showing position of baling press.

over which is run a large car carrying the freshly dried hops. T sides of the car are hinged so as to swing open from the sloping b tom, allowing the hops to be readily removed with little handlin

The hops are spread out on the floor of the cooler, where they lose their heat and absorb some moisture from the air. The stems are usually not so dry as the other parts of the hop, and during the sweating process the moisture is equalized and the hops become tough and pliable. The best-informed growers recognize that other important changes occur during the sweating process which materially affect the quality of the product. A finer and more pleasing aroma, as well as a better physical appearance, is developed during sweating, provided the process is carefully watched and the hops prevented from becoming too moist or heated. Under ordinary circumstances these two evils are avoided by loosening up the hops and turning them over with forks or by moving them to another part of the cooler. If taken in time, slack hops may be brought out in this way and practically freed from their sour, musty smell. If the hops in the cooler become too moist, their condition may be improved by dumping over them a car full of hot dry hops just from the kiln. Likewise hops that have become too dry in the cooler may be helped by mixing with them hops taken from the kiln a little before they are properly dry. Great care and good judgment are necessary for proper handling in the cooler, and more attention given to this phase of hop curing will certainly result in an improved quality of product.

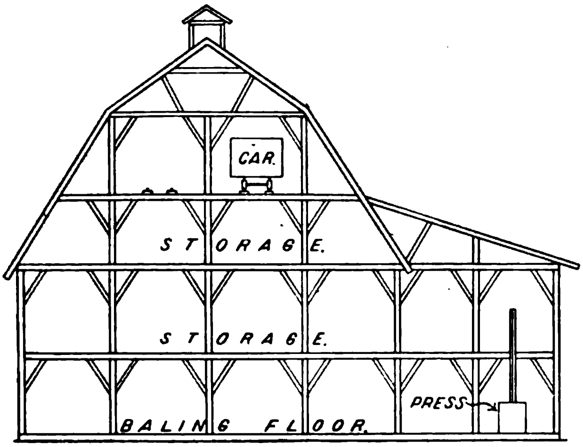

FIG. 16.—Sectional elevation of cooling house.

BALING.

After the hops have been in the cooler for a week or ten days they will have passed through a sweating process and be in good condition to bale. Hops may be left in bulk for many weeks and suffer little injury if the storehouse is tightly closed to exclude atmospheric moisture. When suitable for baling, hops contain just enough moisture to make them pliable and to prevent their breaking when compressed. If too much moisture is present in the bale, the hops will soon heat and turn black, being damaged thereby both in color and aroma, or they may be ruined entirely.

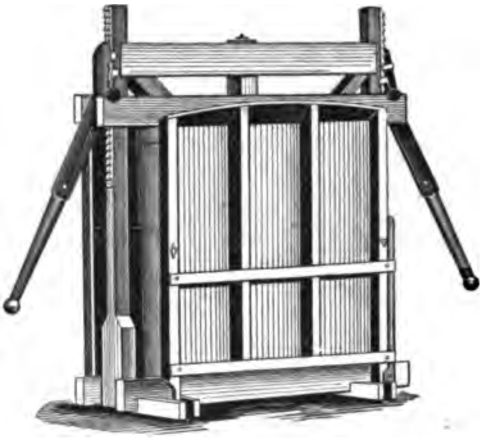
Fig. 17.—A baling press operated by hand.

For pressing the hops into bales several styles of hop baler are used. In some sections where only a small crop is produced a hand-lever press is used. The form of this style of press, shown in figure 17, produces a bale measuring 24 by 18 by 63 inches.

For handling large crops some form of power press is always employed. A modern press which is easily operated with one horse is shown in figure 18. This is a vertical machine 10 feet 4 inches high and 30 inches wide. The doors swing upward to open and when closed are locked by a bar lock that fits a lug at each end of the press. The end gates are loose and may be easily removed when the doors are open. The follower is made of 4 by 4 inch timber and 1¼-inch boards, with a 1 by 6 inch steel bar across the top, to the ends of which twin cables are attached, by means of which the follower is brought down. The cables wind on a winch made with a 26-inch sheave and a 6-inch drum, using a sweep 12 feet long. Since the cable is wound first on the 26-inch sheave and then feeds onto the 6-inch drum, the downward motion of the follower is rapid at first, but becomes very slow as the volume of hops reaches the proper size for the bale. In this press the box is refilled and the follower brought down the same time for each bale. The bale produced usually measures 19 by 26 by 53 inches.

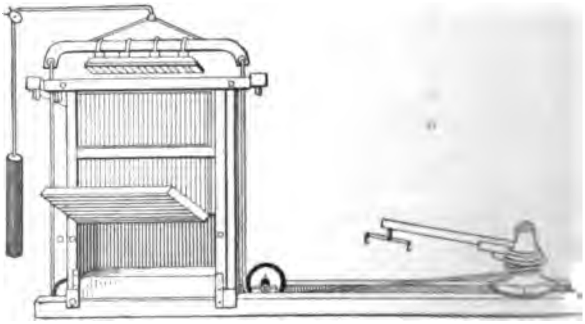
Fig. 18.—A power press operated by one horse.

The so-called Sacramento or "bull wheel" press (fig. 19) requires two horses for its operation. The box of the press measures 20 by 52 inches and is 8 to 10 feet high. Below the box is a 3-inch steel shaft, on one end of which is fastened a power wheel from 10 to 12 feet in diameter. On the shaft are two 8-inch pinions which mesh into cog racks 4 inches wide bolted to two 4 by 4 inch 16-foot scantlings which work up and down. These scantlings are connected at the top by a 4 by 12 inch crosspiece 7 feet long. From the crosspiece drop two 4 by 4 inch pieces from 8 to 10 feet long, to the free ends of which is attached the follower, which fits into the box and, when the power is applied by means of the rack and pinion, presses down the hops.

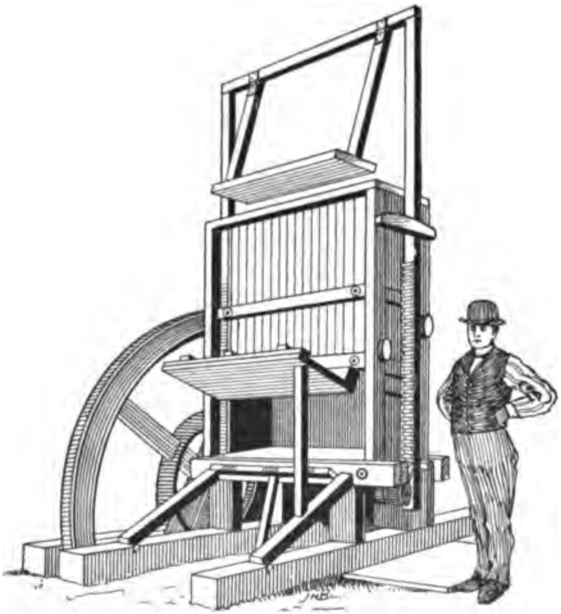

FIG. 19.—A power press operated by two horses.

The lower section of each side of the box consists of a door hinged to open upward. In baling, the bottom of the press is covered with a piece of baling cloth 2½ yards long and from 42 to 46 inches wide, the doors are closed, the box is filled with hops, another similar cloth is spread over the hops, and the follower is brought down. The doors are then opened, the edges of the cloth sewed together with hemp baling twine, and the bale is removed from the press. The average bale from this press measures 20 by 24 by 52 inches and weighs 180 to 200 pounds.

The practice of trampling the hops to facilitate filling the box should be entirely discontinued, since the broken hops resulting therefrom detract from the selling qualities. While filling the box the corners of the bale may be slightly tamped, but even this should be carefully done, especially if the hops are dry. More careful handling is urged, as the hops are often broken and crushed on the floor before being baled and this gives them a bad appearance.

Hops are baled in jute bagging, 16 threads or less to the inch. About 5 running yards of bagging are required for each bale. This weighs from 7½ to 10 pounds, and for it 5 pounds tare is allowed in selling.

COST AND YIELD OF CROP.

The cost of production varies so greatly, owing to differences in the value of land, price of labor, yield, and methods of operation in different sections of the United States, that it is not feasible to attempt to estimate the total expense of producing a crop. The danger of loss incident to unfavorable weather or attacks of insect pests renders hop growing much more precarious than raising other staple crops. The difficulty of securing sufficient help at picking time has added much to the hazards of the crop in recent years. Some estimates of the more important expenses of production are as follows:

Important items of cost in hop production.

Roots	per thousand	$2.00	to	$8.00
Trellis	per acre	80.00	to	90.00
Twine	do	4.00	to	7.00
Cultivating	do	6.50	to	18.00
Training	do	11.00	to	22.00
Spraying	do	4.00	to	12.00
Picking	per dry pound	.03½	to	.05
Curing	do	.01	to	.01½
Baling:				
For cloth and twine	per bale	.60	to	.90
For labor	do	.15	to	.25
Hop press		30.00	to	400.00

The yield varies widely according to the locality, and within th locality according to soil conditions. In the following table is show the average production of hops per acre for the principal ho growing States, according to the report of the United States Cen for 1900:

TABLE 1.—*Average production of hops to the acre in the United States f years 1879, 1889, and 1899.*

States.	1879.	1889.	1
	Pounds.	*Pounds.*	*P*
New York	554	547	
Oregon	840	1,155	
California	1,022	1,648	
Washington	1,317	1,626	

In seasons of good production, on the better soils, the yield w usually be much larger. In California an acre may produce 1, to 2,400 pounds; in Washington, 1,200 to 2,000 pounds; in Oreg 1,000 to 1,600 pounds, and in New York, 800 to 1,500 pounds.

The following figures from Bulletin No. 50 of the Bureau Statistics, United States Department of Agriculture, give the a proximate annual production for the United States as compiled from unofficial estimates for the years 1901-1906:

TABLE 2.—*Annual production of hops in the United States from 1901 to 1906, inclusive.*

States.	1901.	1902.	1903.	1904.	1905.	1906.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
New York	9,000,000	5,850,000	9,000,000	11,880,000	9,360,000	12,060,000
California	9,360,000	10,335,000	10,920,000	12,285,000	14,235,000	20,475,000
Oregon	13,845,000	16,965,000	17,550,000	17,550,000	22,191,000	23,985,000
Washington	6,630,000	5,850,000	6.825,000	7,410,000	9,750,000	8,775,000
Total	38,835,000	39,000,000	44,295,000	49,125,000	55,536,000	65,295,000

MARKETING.

The most serious problem confronting the hop grower is how to market his product at a figure which will give a fair return for investment and labor. Owing in part to great fluctuations in prices, hop growing from a business point of view is extremely variable and uncertain. The state of the market is determined largely by the stock of hops held in storage from the previous year, by the crop conditions at home and abroad during the current year, and by the probable demand as judged from a comparison of the two conditions just mentioned. While the state of the market is conditioned by these three factors, it is influenced heavily by the dealers, hop merchants, or middlemen who stand between grower and consumer.

Hops may move into the market in a number of ways and reach the consumer through various channels. The relations of grower and consumer in some of the more direct lines of transfer are illustrated in the accompanying diagram (fig. 20).

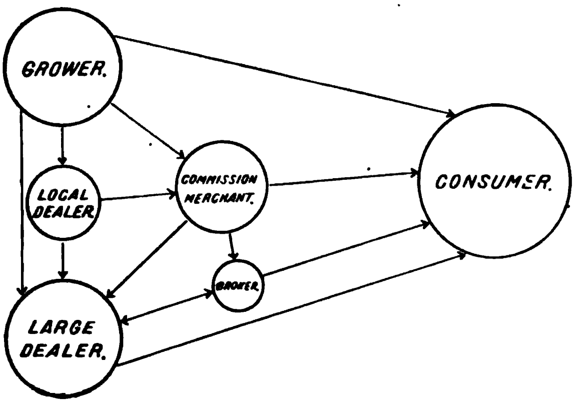

FIG. 20.—Diagram showing movement of hops into market.

Only a small percentage of hop growers sell direct to consumers, so the bulk of the trade passes through the hands of middlemen. Sales may be made to the large dealer direct through his buyers or to the local dealer, who in turn sells to the large dealer; or growers may sell through a commission merchant who may act as agent for both grower and consumer. The broker, or factor, serves as a go-between for dealers or for dealer and consumer. All these middlemen occupy a recognized legitimate place in the trade so long as they confine their operations to buying and selling at market prices as fixed by supply and demand and depend for their profits upon the favorable terms which they may be able to make in the regular course of trading. Under existing conditions the hop crop could not be marketed without the middlemen. Growers with small holdings remote from consumers could scarcely find a market for their product. even if the difficulties involved in arranging credit were overcome. The grower is usually in need of money and demands immediate payment; on the other hand, the consumer may not have funds available to pay cash for his hops at the time when it is necessary to make the purchase. The dealer solves the difficulty by relieving the grower of his stock and making cash payment therefor or a suitable short-time arrangement and by selling to the consumer on terms to suit his convenience.

Although much significance is commonly attached to the locality in which the hops are produced, it is apparent that too much emphasis is laid on geographical origin as a standard of quality. It has been repeatedly demonstrated that dealers and consumers can not tell with certainty the section of the country a sample comes from by examination alone. Even samples from the same yard, when the conditions of drying have differed somewhat, have been ascribed to widely different sections by expert judges of hops.

The price which a consumer will pay for hops depends largely on their origin, thus making it frequently possible to deliver hops grown in one section when the sale was made on hops from another which commanded a different price. Unfortunately, there is no definite standard of quality in judging hops, and there is apparently too much importance attached to origin alone. While geographic origin may be of some importance, its usefulness as a standard of quality is small compared with the tests usually applied in judging the value of hops. In determining the relative quality of different lots of hops a fixed standard of valuation founded on intrinsic qualities rather than preference would be exceedingly valuable to both producer and consumer.

The present unsatisfactory conditions of marketing offer opportunities for improvement along several lines. One of the greatest needs of the hop industry is more complete and accessible statistics of production and consumption, not only that growers may govern their acreage by the prospective demand, but that, by knowing the amount consumed during the current year, the stocks remaining in the hands of the consumers, and the crop conditions at home and abroad, an intelligent opinion may be formed as to the probable rela tion between supply and demand and what prices may therefore be reasonably expected. From the return made by the officers of the internal-revenue service a quarterly statement would show the total amount of hops consumed, and from the consumption—its increase or decrease—the market possibilities could be inferred. Also the necessity is very great for frequent reliable statements of European crop conditions. The hop market is controlled by the production in the United States, England, Germany, and Austria; and, since the surplus production of the United States is exported almost entirely to England, crop conditions abroad practically control American prices. More reliable and detailed statistics of home production are needed. So many exaggerated reports are circulated for the purpose of influencing the market that an exact census of the acreage set out, the acreage harvested, and the number of bales produced would be of incalculable benefit to the producer; and this end would be much furthered by thorough cooperation on the part of the hop growers themselves.

On the Pacific coast several hop growers' associations have been organized along similar lines and with the same general purpose as the citrus growers' associations and others in southern California. Other organizations modeled along the lines of the hop growers' associations or cooperative unions of Europe should enable growers to protect their interests better and to secure recognition unobtainable as individuals. The industry is so centralized in the various States that a very small number of associations could easily include practically all the growers in their membership. With proper cooperation on the part of the members of the associations and the abandonment of the attitude of suspicion and distrust which too often characterizes the relations of producers with each other, it should be possible for growers to secure the adequate collection and distribution of the most necessary statistics of production and consumption and to more fully acquaint themselves with the need of better methods and of greater facilities for handling the business.

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FARMERS' BULLETIN 305.

Experiment Station Work,

XLII.

Compiled from the Publications of the Agricultural Experiment Stations.

EXTENSION OF RICE CULTURE.
GROWING SEED POTATOES UNDER MULCH.
MANURE AS A SUMMER MULCH IN FORCING HOUSES.
RENEWAL OF OLD ORCHARDS.
INJURY BY BORDEAUX MIXTURE.
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ROOTS FOR FARM ANIMALS.
CABBAGE AS STOCK FEED.
PASTURING HOGS.
CULL BEANS AS A FEED FOR HOGS.
HEALTHY POULTRY.

JULY, 1907.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
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1907.

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  - College Station: *Columbia;* H. J. Waters.[a]
  - Fruit Station: *Mountain Grove;* P. Evans.[a]
- Montana—*Bozeman:* F. B. Linfield.[a]
- Nebraska—*Lincoln:* E. A. Burnett.[a]
- Nevada—*Reno:* J. E. Stubbs.[a]
- New Hampshire—*Durham:* W. D. Gibbs.[a]
- New Jersey—*New Brunswick:* E. B. Voorhees.[a]
- New Mexico—*Agricultural Colle* L. Foster.[a]
- New York—
  - State Station: *Geneva;* W. H. Jordan.[a]
  - Cornell Station: *Ithaca;* L. H. Bailey.[a]
- North Carolina—*Raleigh:* B. W. K gore.[a]
- North Dakota—*Agricultural Colle* J. H. Worst.[a]
- Ohio—*Wooster:* C. E. Thorne.[a]
- Oklahoma—*Stillwater:* W. L. E lish.[a]
- Oregon—*Corvallis:* J. Withycombe.
- Pennsylvania—*State College:* T. Hunt.[a]
- Porto Rico—***Mayaguez:*** D. W. May.
- Rhode Island—*Kingston:* H. J Wheeler.[a]
- South Carolina—*Clemson College:* N. Harper.[a]
- South Dakota—*Brookings:* J. W. W son.[a]
- Tennessee—*Knoxville:* H. A. gan.[a]
- Texas—*College Station:* J.W.Car
- Utah—*Logan:* E. D. Ball.[a]
- Vermont—*Burlington:* J. L. Hills
- Virginia—*Blacksburg:*
- Washington—*Pullman:* E. A. Bry
- West Virginia—*Morgantown:* J. Stewart.[a]
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- Wyoming—*Laramie:* B. C. Buffu

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

EXTENSION OF RICE CULTURE.[b]

Rice production in this country and the acreage allotted to the crop has in recent years undergone an enormous increase. As pointed out by the Twelfth Census, only 161,312 acres were grown in 1889 and 342,214 acres in 1899, while according to statistics gathered by this Department the area devoted to the crop in 1905 was 482,479 acres and the total production for the year amounted to 13,606,989 bushels. The first rice was grown in the United States about the middle of the seventeenth century, and the crop was introduced into South Carolina toward its close. For years our rice culture was limited to certain sections along the South Atlantic coast, until within recent years some of the prairie lands of Louisiana and Texas were opened up to the culture of the crop.[c] During the last four or five years a good beginning in rice culture has also been made in Arkansas, with results indicating the possibility of widely extending the area of profitable rice culture on lands not hitherto considered adapted to this crop.

In 1902 the Arkansas Experiment Station, in cooperation with a farmer who conceived the idea of growing rice on Arkansas prairie lands, introduced rice culture on a limited scale in Lonoke County, a little southeast of the center of the State. A good stand was obtained from the first sowing, and the result secured demonstrated that the crop can be successfully grown on these prairie lands when proper irrigation facilities are provided.

The following year the station, in cooperation with the Irrigation and Drainage Investigations of the Office of Experiment Stations of this Department, sank a well, installed machinery, and constructed levees to put a greater area under irrigation. In 1904 10 acres were grown, and although the crop was not sown until late it was successful from the beginning, one plat yielding as high as 75 bushels per

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Arkansas Sta. Buls. 89 and 94.

[c] See also U. S. Dept. Agr., Farmers' Bul. 110, Rice Culture in the United States, by S. A. Knapp.

In 1905 the area was increased to 30 acres, but owing to unfavorable weather conditions only 25 acres were harvested. About 17 acres of Honduras rice yielded 53 bushels and about 8 acres of Japan 53 bushels per acre, the average for the two varieties being 57.8 bushels.

In 1906 the acreage of rice was greatly increased over that of previous years. The industry had extended from Lonoke to Prairie, Arkansas, Lee, and St. Francis counties, and the total area devoted to the crop was about 5,000 acres. The total production was estimated at over 100,000 bushels. The season was in many respects very unfavorable for growing rice, yet where the soil was well prepared, the crop planted early, irrigated properly, and harvested at the right time the yield was satisfactory. A rain and wind storm on September 23, when the late planting had not yet been harvested, damaged the crop from 5 to 12 per cent, and still greater injury was sustained from an early frost in October. Much of the loss was due to late sowing, on account of heavy rains, and also the result of showers during the period of pollination.

For the experiment station crop in 1906 is was impossible to plow the land early on account of heavy rains in the fall and winter of 1905, and it was not until April 16 that the stubble was turned and not until April 28 that the land was finished. The ground was very rough and cloddy and it was necessary to disk it three times and to smooth it down with the harrow. The seed was sown broadcast at the rate of from 1¼ to 1½ bushels per acre, then disked in and crossed with a smoothing harrow. The first sowing was made April 20 and the maximum yield, 77.76 bushels per acre, was harvested from that plat.

The Honduras variety produced at the rate of 61.84 bushels and the Japan 52.44 bushels per acre, the average being 57.5 bushels. The irrigation period of this crop was eighty-four days. Contrary to the experience of the two preceding years, Honduras rice produced the maximum yield, probably owing to the fact that the Japan plats were all planted much later and therefore suffered from storms, cool nights, and early frosts. Where the two varieties were sown on sod land under the same conditions Japan made a much better yield. Honduras rice is named for the country from which the seed came, and Japan, a hardy variety, was recently introduced from that country by this Department. These two varieties, which are the only kinds now planted in Arkansas, are briefly described as follows:

The Japan has a short, thick kernel, a thick hull, and heavy grain. It is not so tall as the Honduras, and the straw is smaller and green when the grain is ripe. The percentage of bran in the Japan is small. Since the grains do not break so badly it will mill more head rice than the Honduras. The market price for Japan, however, is a little less than for Honduras, but the yield is greater. The Honduras has a large grain, a tall, stiff stalk, and is not so easily blown down. Both varieties have their advantages and disadvantages. Our experiments, based upon two years' tests, proved that Japan is well adapted to our soil and climate. Japan may be planted later than Honduras with good results.

The character of the soil of the Prairie Longue and Grand Prairie regions of Arkansas, which have been found especially adapted to rice culture, are thus described:

> The low, level character of the land, the stiff texture, and impervious subsoil are peculiarly favorable to holding water during irrigation, thus economizing the amount necessary. The ground dries immediately after the water has been turned off, so the binder and team will pass over it. An abundant supply of pure water can be secured from wells ranging in depth from 100 to 200 feet. The geological formation is such that the lift is not usually more than from 20 to 40 feet. Delta lands of the Mississippi and those of the rivers of the Carolinas and Georgia produce a fine grade of rice, which reaches the market early and brings fancy prices. However, in many cases these lands are not adapted to the use of the improved machinery, consequently the expense of growing the crop is greater than that of the prairie lands.
>
> The alluvial lands of south Arkansas are in many places adapted to rice culture. Pure warm water, with nitrates and other soluble plant food, can be taken from lakes, ponds, bayous, and rivers at very little expense.

It is stated that the lands which are now devoted to rice are lands that, owing to lack of drainage and reclamation, were not adapted to other field crops and were almost exclusively used for grazing. A farmer planted 40 acres of bottom land lying adjacent to Bearskin Lake with rice in order to determine whether irrigation would kill nut grass, which was very abundant in the field, and at the same time produce a crop of rice. The experiment was successful and an average yield of 46½ bushels of rice per acre was secured.

The time of planting largely depends upon the season, but it is recommended that for southern Arkansas the crop be planted as soon as all danger of frost is over and the ground warm enough to germinate the seed, which will usually be from April 1 to May 15. Honduras should be planted earlier than Japan, which may be sown any time until May 15.

So far few insect pests and fungus diseases and no noxious weeds, except red rice, have appeared in the rice fields of the State.

Red rice, according to Dr. S. A. Knapp, " is so called from the red color of the grains. In most cases the grain is colored a dark red through the entire substance. In other instances seeds may present any shade of color between the red and the white; again, only the seed coat contains the coloring matter, and in this case the grain comes from the mills clean and white, or with little stripes of red where the coat has been imperfectly removed." The presence of a few grains of red rice in milled rice lowers its grade and reduces its price. It is, therefore, important to keep red rice out of rice fields.

In order to keep red rice from the rice field it is advised to grow a few acres isolated and planted on sod or new land for seed, and to select the largest, earliest, and best heads for the next crop. When red rice appears the field should be plowed, disked, and harrowed as soon as the crop is harvested. If the land is dry and hard, flooding will germinate many of the seeds, which will then be killed during the winter. Other seed germinating in the early spring may be killed by spring plowing. When red rice has obtained a firm hold in the field, some other crops should be grown until the weed has disappeared, and if the land is too low and acid to produce good crops, it may be fall plowed and left in fallow until spring, plowed again, fallowed until midsummer, and then plowed for a crop of rice.

Suggestions regarding methods of culture adapted to Arkansas conditions are given in the bulletins from which this article is compiled.[a]

GROWING SEED POTATOES UNDER MULCH.[b]

R. A. Emerson, of the Nebraska Experiment Station, has reported an interesting comparison of the value for seed purposes of potatoes grown under mulch with those grown with ordinary cultivation under like conditions, which indicates that the mulch method offers a convenient and practical means of producing good home-grown seed under Nebraska conditions. The theory of the method and the results obtained in the comparative tests are thus stated:

> Potatoes are a cool-weather crop. It is because of this that they succeed so well in the far north. Moreover, potatoes require for their best development fairly uniform conditions, especially as regards soil moisture and soil temperature. This being the case, why should not potatoes grown under a litter mulch be especially well developed and therefore make strong seed? The soil beneath a mulch not only has a moderately low temperature during summer, but its temperature is also exceptionally uniform, varying not more than a degree or two between day and night and only a few degrees from day to day. The soil moisture beneath a good mulch is also more abundant and much more nearly uniform in amount than in case of bare ground, even though the latter is given good tillage.
>
> The value for seed purposes of tubers grown under a litter mulch has been tested during two seasons at the experiment station. In 1904 a plat of potatoes was mulched with straw and an adjoining plat was given careful cultivation. The soil of the two plats was practically uniform and the seed planted on the two plats was taken from the same lot of tubers. Seed was saved from the mulched and cultivated plats separately, kept under the same conditions during winter, planted on adjoining plats in the spring of 1905, and given identical cultivation during the summer. In 1906 the experiment was repeated with seed grown in mulched and in cultivated ground the year before. The same precautions were observed as in the first test. Uniform seed was used to start

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[a] See also U. S. Dept. Agr.' Farmers, Bul. 110.

[b] Compiled from Nebraska Sta. Bul. 97.

with in 1905. The seed saved from the mulched and from the cultivated plats was taken as it came, without selection, and was kept over winter under the same conditions. Both kinds of seed were cut in the same way, planted in the same way, on adjoining plats, and treated alike as regards tillage, spraying, etc. Under these conditions any constant differences in yield between the two plats must be ascribed to the effect of the methods of culture employed the previous season. The yields obtained from the mulched and from the cultivated seed were as follows: Cultivated seed, 384 pounds in 1905; mulched seed, 563 pounds in 1905; cultivated seed, 123 pounds in 1906; mulched seed, 174 pounds in 1906.

The use of seed that had been grown under a mulch the preceding year increased the yield of potatoes 47 per cent in 1905 and 41 per cent in 1906. If further tests confirm the results reported here, it would seem that mulching might be used for the production of high-grade seed potatoes at home. Moreover, mulching usually results in increased yields if properly handled. Mulching potatoes on a large scale is of course impracticable, but most farmers could easily mulch enough of their potato field to produce the seed that they would require the following year, and in doing so they would not necessarily increase the cost of production per bushel.

The method migh be tried with advantage in other regions than Nebraska, where warm, dry seasons prevent the production of vigorous seed by ordinary methods.

MANURE AS A SUMMER MULCH IN FORCING HOUSES.[a]

In experiments made by G. E. Stone, of the Massachusetts Experiment Station, it was found that the practice common among those engaged in forcing vegetables under glass of allowing the soil of beds to become very dry during that portion of the season when the houses are not in use has an injurious effect on the growth of lettuce by increasing the activity of the "drop" fungus in the soil and the extent of infection in the succeeding crop of lettuce. Other injurious effects were also observed which were "manifested in a stunted growth and abnormally colored and worthless crop." Doctor Stone therefore recommends that the soil of houses used for forcing lettuce should never be allowed to become too dry in summer, and explains that "if such drying occurs the soil can be entirely renovated by applying hot water or steam to it."

The Ohio Station reports experiments begun three years ago to determine "what effect the use of strawy manure would have on the soil when used as a mulch during that part of the summer when crops are not growing in the greenhouses," which gave results bearing upon the question of the advantage of keeping greenhouse soils moist in summer.

The manure was applied as soon as the tomato and cucumber vines were removed from the houses, or about the first of August. It was put on to a depth of from 5 to 6 inches and spread evenly over the entire surface of the beds. As soon as it was on, water was applied in the form of a spray until the manure and soil were thoroughly wet.

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[a] Compiled from Ohio Sta. Circ. 69.

The object of this wetting was, first, to leach the fertility of the manure into the soil, and, second, to wet the soil sufficiently so that with the strawy mulch it would remain moist for several days. The operation of watering was repeated as often as needed; two or three times a week in bright weather.

When it came time to plant the lettuce, about the middle of September, the coarse part of the manure was removed from the beds and carried outside. The finer portion of the manure was worked into the soil at the time of spading.

It was noticeable that the soil which had been treated with the mulch was in excellent mechanical condition when it was worked up for the first crop. There were no lumps, as there often are in soil which has been allowed to bake in the sun for weeks at a time. It was also darker in color than unmulched soil. The lettuce plants which were planted in this soil started off nicely and grew rapidly and satisfactorily in every respect. No further application of manure or fertilizer of any kind was made for the second and third crops of lettuce. The growth of these crops was very satisfactory, as was that of the first crop.

The method gave such favorable results at the station that a practical grower of forcing-house vegetables was induced to try it.

Taking the results of the station tests for the two seasons, together with the results secured by the [practical grower] for the same length of time and gleaning what information it has been possible to obtain from various sources, the station does not hesitate to recommend this treatment for soils which are to be used for vegetable forcing. It must be borne in mind, however, that no half-way or slipshod methods of using the mulch will give satisfactory results. There should be sufficient fertility in the manure to furnish enough plant food, when leached into the soil, to supply the three crops of lettuce. The quantity of manure must be sufficient, also. At least 5 or 6 inches should be applied. A considerable quantity of coarse material in the manure, such as straw, corn stover, etc., is an advantage. Fresh manure has been used at the station each time, and, while we have had no chance to see the effect of the use of the well-rotted manure, we are satisfied with fresh manure, as we know that it will give good results.

Where it is the practice to mulch the cucumber or tomato crop, the manure used for that purpose can be left on and more added, provided the cucumbers or tomatoes have been free from disease. In case these crops have been diseased, it would be advisable to remove the mulch used on them and apply new.

Frequent sprinkling of the manure on the beds is very essential.

When it comes time to put in the first crop, if the soil is in need of humus, the entire mulch may be spaded into the soil, but most greenhouse soils do not need the addition of so much coarse material. Where the soil is fairly well supplied with humus, the coarser part should be taken off and removed from the houses and the finer portion worked into the soil.

The fact that the greenhouses in which the mulch was used were very free from lettuce disease "would lead us to expect beneficial rather than detrimental results from the proper use of summer mulch in so far as it affects the diseases of lettuce." If the use of mulch has any beneficial effect as regards diseases, it is entirely a preventive measure and not a cure. Neither this method nor any other will prevent damage which results from bad methods of handling the crop.

RENEWAL OF OLD ORCHARDS.[a]

F. H. Ballou, of the Ohio Experiment Station, maintains that old neglected orchards, which have been overgrown with weeds and brambles and have become not only worthless but a menace to new, well-cared-for orchards, may be "renewed" so that they may be a valuable source of fruit, especially while new orchards are coming into bearing.

Instead of these orchards being destroyed to prevent the spread of diseases and noxious weeds to newly planted orchards he explains how they may be renewed in such a way that the injurious insects and diseases may be effectually and easily combated and controlled, and the old trees made to produce fine fruit for home and market while the young fruit trees are growing.

Mr. Ballou explains at the outset that "renewal is a reversal of the generally prevailing idea of 'pruning up' old trees. It is distinctly a process of 'pruning down.'"

The type of trees with which renewal is not practicable is that type whose heads have been formed at an extreme height from the ground, and whose naked branches, from that elevated point of divergence, extend many more feet upward and outward with no intervening smaller branches. Usually a tree that was originally headed moderately low, and whose lower branches are in good condition, can be successfully renewed.

Cut out the topmost branches the first season of renewal, leaving all healthy side branches. The next season these horizontal branches may have their extremities lopped back with the pruners in such a way as to promote a uniform, well rounded, symmetrical head or top.

It will be necessary to saw large branches first on the under side, then on the upper side, a few inches farther out or up the branch in the direction of its growth. This allows the branch to break off without splitting the part remaining. A second cut, at an angle, can then be made without difficulty, leaving a smooth, clean-cut stub.

All wounds should be dressed, a few weeks after cutting, with a thick paint made of pure white lead and boiled linseed oil.

The benefits of heading back will be lost, in time, unless the work be followed up by annual, discriminate thinning of the new shoots, and cutting back of those selected for future fruit bearing.

Renewal of orchards may profitably be accompanied by the addition of stable manure, either worked into the soil beneath the extremities of the branches, or allowed to remain upon the surface to be covered later with straw or other coarse material applied as a mulch. The combination of renewal and fertilization will work wonders in the rejuvenation of many old orchards long considered unprofitable and valueless.

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[a] Compiled from Ohio Sta. Bul. 180. See also U. S. Dept. Agr., Farmers' Bul. 169, p. 16.

INJURY BY BORDEAUX MIXTURE.[a]

While it is recognized that Bordeaux mixture is the most efficient fungicide now known for combating many diseases of fruit, particularly those of the apple, evidence has been collected by the New York State Station which shows that it is not a perfect application for use in apple orchards, since under certain conditions the mixture itself, even when made and applied with extreme care, may spot the leaves and mark or deform the fruit.

On the foliage, Bordeaux injury greatly resembles the leaf spot supposed to be caused by fungi. Dead, brown spots first appear, which may be small, circular or roundish, or larger and of irregular shape as though several small spots had run together. The living and dead tissue are separated by a distinct line, so that the spotting is very conspicuous. Later, if the injury is severe, the leaf turns yellow over more or less of its surface and finally drops off as in natural falling. Many of the orchardists reporting place the amount of defoliation during 1905 at one-half or more of the leaves; while in a few instances nearly all of the first leaves fell.

On the fruit the injury first appears as minute, round, black, or brown spots or specks, less than pin-head size, which are clustered either (1) at the apex of the fruit if the injury results from spraying before the little fruits have turned down, or (2) at the base of the fruit if the injury results from later sprayings. Subsequently the characteristic "spray russeting" or "cork russeting" appears. The plant cells injured by the spray form thick, corky tissue, which roughens or russets the apple, the extent of the marking varying with individual fruits. These characters give the fruit the appearance of having been attacked by a fungus. Brightly colored fruit is much marred, both by the russeting and by a decreased brilliance of the unspotted areas. Badly injured specimens are always more or less distorted in shape, the affected areas being usually shrunken. Occasionally unsightly, teat-like malformations are produced, or gaping cracks in half-grown fruits which heal over as the fruits develop, leaving rough sunken scars.

These injuries affect the keeping qualities of the fruits to a marked extent, the moisture being rapidly given off, in dry rooms or cellars, through the corky tissue, so that the flesh below shrivels or becomes mealy, or in extreme cases may turn brown as if bruised or exposed to the air. In such cases decay sets in rapidly. With late-keeping apples this phase of the injury is very important, as the keeping quality is affected, no matter how slight the russeted area.

In cold storage the depreciation of russeted apples is not very rapid, but such fruit is not wanted by retailers, as it keeps very poorly when brought from storage into a dry atmosphere.

Certain injuries to foliage and fruit may be confused with Bordeaux injury, though usually there are points of difference easily separating them.

A perfect method of preventing the injury has not been devised, but U. P. Hedrick and F. H. Hall, of the New York State Experiment Station, give the following suggestions which will aid in reducing it:

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[a] Compiled from New York State Sta. Bul. 287.

(1) Distinguish, in spraying, between varieties very susceptible tō spray injury and those resistant or less susceptible. Among such susceptible varieties, which must be sprayed with great care, are: Baldwin, Ben Davis, Gravenstein, Jonathan, Rhode Island Greening, Twenty Ounce, Wagener, Wealthy, Yellow Newton, Yellow Transparent. Among those less susceptible are: Alexander, Esopus Spitzenburg, Fall Pippin, Hubbardston, Northern Spy, Red Astrachan, Red Canada, Rome, Roxbury, Tolman Sweet, Tompkins King, Yellow Bellflower.

(2) Varieties resistant to scab should receive light applications of Bordeaux, especially if they are very susceptible to injury by the copper sulphate. Among such scab resistant varieties are: Alexander, Ben Davis, Gano, Hubbardston, Oldenburg, Red Astrachan, Rome, Roxbury, Sutton, Tompkins King, Tolman Sweet, Wealthy, Yellow Newton, and Yellow Transparent.

(3) It will probably be best to use less copper sulphate. On this point it is not possible at present to speak positively. * * *

(4) An excess of lime will not prevent Bordeaux injury nor greatly lessen it; therefore it is not advisable to use more than one part of lime to one part of copper sulphate in making the mixture.

(5) Use moderation in spraying. Since the injury increases with the amount of copper sulphate, an excessive application that leaves, by evaporation, larger amounts of the chemicals on the tree will be more harmful than lighter applications. Spray to cover the foliage and fruit with a thin film and yet not have the trees drip heavily.

(6) Avoid spraying in rainy, foggy, damp weather. Applications made just before showers are quite certain to produce injury; hence the Bordeaux mixture should be used, as far as possible, only in dry weather. If necessary to spray in wet weather it may be advisable to increase slightly the proportion of lime in the mixture.

In general it is pointed out that while spray injury is a serious matter, apple scab is worse, and " no fruit grower can afford to give up the use of Bordeaux mixture in fighting apple scab."

GLUTEN FLOURS AND SIMILAR FOODS.[a]

When wheat flour is made into dough and frequently washed, preferably in running water, the starch may be removed, leaving behind a tenacious gummy mass known as gluten, which contains practically all of the nitrogenous material originally present in the flour. This may be dried and ground or manipulated in various ways, and gluten goods are manufactured on a commercial scale and sold under such names as wheat gluten, gluten flour, etc. The experiment stations have examined such goods, which are widely used by persons suffering with diabetes and others who are compelled to exclude starch from their diet, and it has been found that they vary very greatly in quality. For instance, some of the products examined by the Maine Experiment Station were found to contain practically the same amount of protein and only a very little less starch than ordinary wheat flour, while other goods showed a high percentage of protein and a low carbohydrate content.

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[a] Compiled from Connecticut State Sta. Rpt. 1906, pt. 2, p. 153; Maine Sta. Buls. 55 and 75.

An extended study of the composition and nutritive value of gluten flours, gluten bread, and similar goods, nut products, soy-bean meal, and other commercial diabetic foods and homemade gluten rolls and soy-bean rolls was recently carried on by the Connecticut State Experiment Station. According to A. L. Winton's report of this work, all the samples of flour and meal examined, except the wheat and barley goods, the soy-bean meal, almond meal, nut meal, and the flours purporting to be made from milk casein, "were shown by microscopic examination to be wheat products."

The samples with less than 15 per cent of protein had the appearance of being untreated mill products with or without the bran coats and germ. Some were gritty—that is, felt rough between the fingers as compared with ordinary wheat flour, which feels soft and smooth. The starch was nearly or quite normal in its appearance under the microscope, showing that it had not been gelatinized as in the manufacture of true gluten flour.

The gluten flours and other flours made from wheat containing 26 per cent and upward of protein showed under the microscope flakes of crude gluten—i. e., a dried mixture of gluten and starchy matter, the latter in some cases being gelatinized. Some of the samples consisted entirely of this material, while others contained in addition what appeared to be untreated flour with normal starch grains.

The samples claimed to be wheat and barley, soy-bean meal, and almond meal were true to name.

The [commercial] bread, biscuit, and rusks for the most part showed under the microscope only wheat starch distorted by cooking, wheat tissues, and, in the case of those with high protein, gluten flakes like those found in the flour. * * * Calculated to the water-free basis, nearly all the samples guaranteed to contain a certain percentage of protein fulfilled the claims of the manufacturers.

All of the wheat preparations contained a certain amount of starch, although in most of them the percentage was considerably reduced. The beneficial results from their use are not due solely to the reduced percentage of starch, but also to the increased percentage of protein. The products are "richer" or "heartier" and the patient eats less of them. For example, ordinary wheat flour contains about 75 per cent of starch and 11 per cent of protein, whereas some of the diabetic flours examined contain about 50 per cent of the former constituent and about 40 per cent of the latter. Pound for pound, the amount of starch is reduced only to two-thirds the original amount, but the protein has been increased nearly fourfold, so that 25 parts of the preparation contain as much protein as 100 parts of the original, but only one-sixth (one-quarter of two-thirds) as much starch. But a gluten flour with any considerable amount of carbohydrates (for example over 10 per cent) should be used in very small amount, if at all, by diabetics. A safe flour for those suffering with the disease is casein flour entirely free from carbohydrates, or else a vegetable flour containing the smallest possible amount of these substances, such as may be prepared from soy beans by simply grinding with removal of the hulls, from almonds and other starch-free nuts after expressing a portion of the fat, or from wheat after washing sufficiently to remove nearly all the starch. A [illegible]

antee as to protein and starch content should be furnished with each product, so that physicians can calculate dietaries for their patients.

[The homemade gluten biscuits and the homemade soy-bean meal biscuits] contained comparatively low percentages of nitrogen-free extract. Although the soy-bean biscuit contained about four times as much nitrogen-free extract as the gluten biscuit, it should be borne in mind that * * * only about one-third the nitrogen-free extract of the soy-bean meal is starch, sugar, and dextrin, also that the nitrogen-free extract as given for the gluten foods is too low owing to the use of an erroneous factor for protein. With our present knowledge it may be safe to assume that both biscuits are about equally unobjectionable so far as their carbohydrate constituents are concerned. They are, however, of a very different nature as regards protein and fat, the soy-bean biscuit being relatively rich in fat, whereas the gluten biscuit is rich in protein. Practical trials alone can decide which is the more wholesome. It seems probable that both can be used to advantage, thus serving to relieve in a measure the monotony of the diet.

As regards the use of foods with little or no starch, the following statements are made:

The necessity of excluding so far as possible from the diet of diabetic patients sugars and substances, such as starch and dextrin, yielding sugar with the digestive juices, has led to the introduction of saccharine and other coal-tar derivatives and preparations containing, or purporting to contain, no starch or starch derivatives, or else diminished amounts of these substances. The craving of the patient for sweets is sometimes satisfied, at least temporarily, by the use of saccharine, a coal-tar product several hundred times as sweet as sugar which is free, so far as diabetes is concerned, from the injurious properties of sugar, but the preparation of a harmless but palatable substitute for bread requires a special flour containing a relatively small percentage of starch and special methods of breadmaking.

So-called diabetic flours may be made from wheat flour by washing out a portion of the starch and drying. If the process of washing is carried far enough, crude gluten is obtained containing very small amounts of starch, and from this, after drying, may be prepared gluten flour. Crude gluten, obtained as a by-product in the manufacture of wheat starch, is said to be utilized for the preparation of gluten flour as well as a concentrated cattle food. The removal of so large a proportion of the starch materially alters the physical characters of the flour and the bread made from it is quite different from ordinary bread. * * *

Most of the commercial diabetic flours, however, are not true gluten flours, since they still contain a considerable amount of starch—some of them so much as to render them positively dangerous for diabetic patients.

Not only all of the cereal grains but also most of the seeds of the legumes, such as field and Lima beans, peas, and lentils, contain large amounts of starch and must be avoided by diabetics; the soja or soy bean, however, is a striking exception as it contains, when ripe, no true starch, or only traces. This leguminous seed is an important food in Japan and is being used in this country for the manufacture of meal for the use of diabetics. * * *

The peanut, another leguminous seed, although very rich in oil, contains about 11 per cent of starch, sugar, and dextrin, of which about half is starch.

Most of the nuts, including walnuts, Brazil nuts, almonds, and filberts, since they contain no starch and only small amounts of sugar and dextrin but are

rich in protein and oil, are valuable additions to the diet of diabetics. Almond meal is used in the preparation of various biscuits and bread substitutes. The chestnut is a notable exception among nuts, in that it is rich in starch and poor in fat, the composition of the shelled nut being much the same as that of wheat flour; it is therefore entirely unsuited for the use of diabetics.

Casein prepared from skimmed milk is used for making a kind of bread entirely free from starch. * * *

In making out dietaries for diabetic patients it should be borne in mind that starch, sugar, and dextrin are all about equally injurious, since starch and dextrin are converted by the saliva and pancreatic juice into sugar (chiefly maltose) and it is the sugar, not the starch itself, which is directly injurious. For example, changing a portion of the starch into dextrin, as is done to some extent by toasting bread, does not render it less injurious; in fact it actually hastens the formation of sugar through the action of the digestive juices, since dextrins are intermediate products in the change. For this reason the sum of the percentages of starch, sugar, and dextrin, and not the starch alone, should be considered in valuing diabetic preparations.

Investigations like those noted above have a decided value, as they furnish information regarding the character of food products in which a great many persons are interested. It should be remembered, however, that those who, for any reason, must exclude starch from their diet should follow the advice of a competent physician and should not depend upon general information and their own opinions in regulating their food.

LAXATIVE PROPERTIES OF WHEAT BRAN.[a]

The laxative properties of bran have long been recognized in the very general use of bran mash to correct a tendency to constipation in farm animals, but the exact reason for this action of the bran has never been clearly understood.

Some recent experiments by W. H. Jordan, E. B. Hart, and A. J. Patten, of the New York State Experiment Station, indicate quite positively that there is a laxative action due to a soluble phosphorus compound known as phytin, which occurs in considerable amounts in the bran, for when cows were fed bran from which this compound had been largely removed by washing they showed a decided tendency to constipation besides other physiological disturbances.

The results obtained in these experiments, while not considered in any sense conclusive, seem also to have an important bearing on human nutrition.

It is generally believed—how correctly is not definitely established—that whole-wheat bread is a desirable food for persons of a constipated habit. The supposed influence is usually attributed to the effect of the coarser material upon the peristaltic action of the intestines. The outcome of this investigation very naturally suggested the thought that if whole-wheat bread really possesses the laxative properties assigned to it, this may be due to the amount of phytin carries rather than to its mechanical condition. * * *

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[a] Compiled from New York State Tech. Bul. 1.

The phosphorus compounds of the wheat kernel are found mainly in the outer coatings and germ from which are derived the bran and middlings. As the bran phosphorus is mostly contained in the compound phytin, it is self-evident that this substance exists in much larger proportion in the whole-wheat bread than in fine flour.

Phytin is widely distributed in nature and has been found in the seeds of the red fir, pumpkin, peas, beans, white and yellow lupines, and potatoes, as well as in wheat.

EMMER AS A FEEDING STUFF.[a]

As fully explained in an earlier Farmers' Bulletin of this Department, emmer, which is a species of wheat (*Triticum dicoccum*), often incorrectly called speltz, was introduced from Russia into the northwestern United States, more particularly Minnesota and the Dakotas, where it has been so successful, especially for dry-land planting, that its culture and use have assumed considerable importance. J. W. Wilson and H. G. Skinner, of the South Dakota Station, say of this grain that "although better adapted to the more arid regions [it] has produced a yield of 63 bushels to the acre on the low land of the college farm. It is now quite generally grown as a grain crop and is highly spoken of wherever fed to live stock."

The characteristics and culture of this crop are fully treated in the Farmers' Bulletin referred to. The purpose of this article is to summarize investigations recently reported by the Minnesota and South Dakota stations, relating to its composition, digestibility, and general feeding value for different classes of farm animals.

The composition of emmer, as compared with other common cereals, is shown in the following table:

Composition of emmer and other cereals.

Kind of grain.	Analyst.	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Unhusked emmer grain as it came from the thrasher.	Snyder, Minn. Station.	10.88	10.50	2.32	60.71	11.70	3.89
Do	Shepard, S. Dak. Station.	10.17	11.58	2.46	61.40	11.45	2.96
Husked emmer	Shepard	10.03	11.69	2.80	70.70	2.94	1.84
Emmer husks	do	8.12	2.39	1.48	41.54	39.02	7.45
Wheat		10.50	11.90	2.10	71.90	1.80	1.80
Barley		10.90	12.40	1.80	69.80	2.70	2.40
Oats		11.00	11.80	5.00	59.70	9.60	3.00

The table shows that unhusked emmer is very similar in composition to oats; the husked emmer more closely approaches barley in chemical composition. In experiments made by H. Snyder, of the

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[a] Compiled from Minnesota Sta. Bul. 90; South Dakota Sta. Bul. 100. See also U. S. Dept. Agr. Farmers' Bul. 139.

Minnesota Station, with sheep, unhusked emmer showed a high digestibility, the digestible nutrients in 100 pounds of emmer as compared with other cereals being as follows:

Digestible nutrients in 100 pounds of emmer and other cereals.

Kind of grain.	Protein.	Fat.	Carbohydrates.
	Pounds.	*Pounds.*	*Pou*
Emmer (unhusked)	9.11	2.14	[illegible]
Barley	8.70	1.60	[illegible]
Oats	9.20	4.20	[illegible]
Spring wheat	10.20	2.70	[illegible]

As measured by chemical composition and digestibility, as determined in the above experiments, emmer should have a high feeding value. Nevertheless, in the actual feeding experiments that have been made this grain has hardly shown as high nutritive value as would be expected from its composition and digestibility.

Summarizing the experiments which have been carried on for several years at the South Dakota Station with all of the more common kinds of farm animals, J. W. Wilson and H. G. Skinner report that in experiments in fattening sheep it required 5.09 pounds of barley as compared with 7.47 pounds of emmer to produce a pound of gain. In comparison with eight other feeding rations in experiments with lambs, it required 7.2 pounds of unground emmer or 8.3 pounds of ground emmer as compared with 5.3 pounds of corn to produce a pound of gain.

In fattening experiments with range lambs emmer was fed as a single grain and mixed with corn, barley, and wheat, half and half by weight. It was found that it required from 1 to 2 pounds more of emmer than of the other grains to produce a pound of gain. The lambs fed a mixture of emmer and barley, half and half by weight made a larger gain for feed consumed than the average of the two lots fed on barley and emmer fed separately. This was also true of the lambs fed corn mixed with emmer in the same proportions as above. The results thus indicate that the emmer had a greater feeding value for lambs when mixed with other grains than when fed alone.

In feeding experiments with dairy cows it required 2 pounds more of emmer to produce a pound of butter fat than it did of barley or corn, other conditions being equal. The cows made a gain in weight of 18 pounds per head during the period. They consumed one-third more of emmer per head daily than did the lots receiving barley or corn. The cows did well on the emmer ration.

In an experiment in feeding for the production of baby beef emmer was used as one of the grain rations, with the result that the fattened on this grain made an average daily gain of 1.69 pounds, while the lot fattened on corn made an average daily gain of 1.84 pounds. During the grazing period the lot fed on emmer gained 112 pounds more than that fed on corn. It required only 5.16 pounds of emmer for a pound of gain, as compared with 7.03 pounds of corn to produce a pound of gain during the grazing period.

The lot fed on emmer did not consume as much hay per pound of gain as did other lots, indicating that the husk of emmer is a good substitute for hay.

Emmer produces a hard fat, about the same as oats, and as good a quality of meat as corn.

With the exception of the emmer lot, the spayed heifers brought the same price as the steers. In this case a reduction of 50 cents per hundred was made on account of the spayed heifer being smaller than the steers in the lot which brought $6 per hundred.

The lot of calves fattened on emmer sold for 40 cents a hundred less on the Chicago market than did the lot fattened on corn, and dressed 2 per cent less than did the corn lot.

In experiments with 2-year-old grade steers it was found that a pound of corn was equal to 1¼ pounds of emmer. Where the corn and emmer were mixed half and half by weight the relation is about the same with a small increase in gain in favor of the mixture. With hogs it required 7 to 8 pounds of emmer, as against about 5 pounds of corn, to produce a pound of gain. Other experiments showed "that there was very little feed for swine when following steers fed on ground emmer."

The results show, in general, that while emmer has a high nutritive value it is hardly equal to corn in this respect. The economy of its use as feed will depend upon its availability and cost.

ROOTS FOR FARM ANIMALS.[a]

Roots as a part of the ration have a decided value for all kinds of domestic animals. Prof. T. F. Hunt and associates, in a recent bulletin of the New York Cornell Experiment Station, in discussing this subject, call attention to the fact that their effect is tonic as well as nutritive, and that breeders and feeders of farm animals for exhibition purposes find roots invaluable.

For most purposes the roots are chopped or sliced before feeding. Various hand and power machines are on the market for this work. Generally speaking, roots should not be fed alone, as they carry too much water. A feed may vary from 25 to 50 pounds per day for a thousand pounds of animal, according to the amount of dry concentrates and roughage fed. It is usual to put the cut roots into the feed box and distribute the ground grain over them. For poultry, however, the whole roots may be given, allowing the fowls to pick them. It is said by some that turnips and ruta-bagas impart a flavor to milk. However, if no roots are in the milking room at the time of milking and they are fed just after milking this may be avoided.

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[a] Compiled from Michigan Sta. Bul. 240; New York Cornell Sta. Buls. 243, 244.

In feeding experiments at the Michigan Experiment Station, in which roots were fed at the rate of 15 to 20 pounds in addition to a silage and grain ration, R. S. Shaw and H. W. Norton, jr., found that—

> The addition of roots to an already complete ration of silage, clover hay, and grain, for a dairy cow, stimulated both milk and butter-fat production.
>
> The cost of the ration, however, was raised to such a degree as to lessen the profit of production, milk costing 4.2 cents more per hundred pounds, and butter fat 1.1 cents more per pound, as a result.
>
> In case a large production is desired, as in making records, roots might be used to advantage.
>
> The cows gained in weight more on the root ration than when fed without roots, but the difference was not great.
>
> The percentage of butter fat in the milk was constant, whether on the "root ration" or without roots.

The roots and tubers most commonly used for feeding farm animals in this country are potatoes and sweet potatoes, beets of different sorts, mangel-wurzels, ruta-bagas and turnips, carrots, parsnips, and artichokes. Many analyses of these roots have been reported in publications of the experiment stations, and the average figures given in the following table are based upon such work:

Average composition of roots and tubers.

Kind of roots.	Water.	Protein.	Fat.	Carbohydrates.		Ash.	[illegible]
				Starch, sugar, etc.	Crude fiber.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	[illegible]
Artichokes	79.5	2.6	0.2	15.9	0.8	1.0	[illegible]
Red beets	88.5	1.5	.1	8.0	.9	1.0	[illegible]
Sugar beets	86.5	1.8	.1	9.8	.9	.9	[illegible]
Carrots	88.6	1.1	.4	7.6	1.3	1.0	[illegible]
Potatoes	78.9	2.1	.1	17.3	.6	1.0	[illegible]
Sweet potatoes	71.1	1.5	.4	24.7	1.3	1.0	[illegible]
Parsnips	83.0	1.6	.5	11.0	2.5	1.4	[illegible]
Mangel-wurzels	90.9	1.4	.2	5.5	.9	1.1	[illegible]
Ruta-bagas	88.6	1.2	.2	7.5	1.3	1.2	[illegible]
Turnips	90.5	1.1	.2	6.2	1.2	.8	[illegible]

As will be seen from the above table, the roots and tubers are succulent foods—that is, they contain a large quantity of water in proportion to their nutritive material. Their feeding value depends in large measure upon the carbohydrates, chiefly starch, which they supply, though the ash constituents are of undoubted value.

The data obtained in investigations reported in the Cornell bulletin referred to on the value of root crops for stock feeding are based on extended experiments on the total dry matter yield per acre of a number of the more important root crops. The results obtained indicate that such root crops as mangel-wurzels, beets, carrots, ruta-bagas, and turnips yield a profitable stock feed under usual conditions.

A greater average yield of dry matter per acre may be obtained from mangels, half-sugar mangels, sugar beets, and ruta-bagas than from an average yield of corn. While it costs somewhat more per pound to produce this dry matter, yet it is quite probable that the higher digestibility and palatability of roots offset this lesser cost of corn. * * *

Comparing mangels and sugar beets, the former are more succulent, while the sugar beets produce a higher average yield of dry matter. It should be remembered, however, that because the sugar beets grow into the ground they are more difficult to harvest, and, furthermore, they do not keep so well as mangels. It may seem that the yield of sugar beets is more uniform than that of mangels, but this is due to the fact that the yield of different varieties of mangels varies more widely than that of the varieties of sugar beets.

The ruta-bagas produce profitable yields of food material, and the fact that they are well adapted to early feeding, and also to the feeding of swine, as well as to sheep and cattle, adds to their value.

Turnips, as a general rule, do not yield as well as the above-mentioned roots, and, furthermore, they are more liable to attacks of disease. However, they are useful for early feeding, and are especially valuable for sheep.

Carrots and parsnips, while yielding a fair percentage of dry matter, do not yield a sufficient quantity of food material to warrant general planting for stock feeding. However, they are exceptionally good as a condimental food, and for horses.

The results of the experiments carried on in 1904–5 at Cornell, the authors believe, show plainly that early planting of roots for stock feeding is desirable. "Ruta-bagas, however, may be planted a little later than the others. It has not been shown that the more fibrous and heavier ruta-bagas of a longer-growing season are less digestible or palatable than the more succulent roots of the shorter-growing season."

The proper methods of harvesting and storing roots are obviously of the utmost importance in the use of such crops for winter feeding. The deductions from the New York Cornell Station experiments which have to do with this subject follow:

Roots are generally harvested by hand, except in the case of the sugar beets, when a plow may be used to raise them from the ground. When turnips, ruta-bagas, and mangels are grown for succession feeding, the turnips are generally harvested first, before frost. Slight frosts in the late fall will not injure ruta-bagas or mangels, although the first frost should be a sign of harvesting time unless it be exceptionally early and very sure to be followed by later warm weather. In late summer and early fall the tops do not grow much, yet the roots are developing and ripening rapidly.

In the case of mangels, ruta-bagas, and most turnips the plants can be pulled by hand, the tops twisted off as they are pulled, and the roots piled or thrown directly into the wagon. It is thought that piling and afterwards loading is less fatiguing than throwing the roots directly into the wagon as pulled. The roots should reach their place of storage with as little dirt and bruising as possible.

Roots may be stored in a cellar or in a pit in the field. The cellar is the better whenever practicable. It may be a part of the barn structure, or built under the driveway of a bank barn, or it may be built as a dugout in a side-

hill near the barn. Perhaps concrete is the best material for construction. It should be not over 7 or 8 feet deep and large enough to hold the yield or supply. It is best to have it located and constructed in such a way that the roots can be dropped in from above, preferably through trapdoors in the bottom of the wagon and the roof of the cellar. It is essential that the walls (if built in the ground) and the floor have good drainage and that ventilation be provided through the top, and that the construction be frost proof. The ventilators should be left open until sweating has ceased, when they may be closed for the winter. In winter the cellar should be kept closed as much as possible on warm days. Roots should be so placed that turnips may be fed first, ruta-bagas next, and after these mangels and carrots.

If stored in a pit in the field, a high, dry place should be chosen. If the ground is clayey, the roots should be placed on top of the ground; if it is gravelly and drainage is good, a shallow pit about 5 feet wide and of necessary length may be shoveled out. The roots should be carefully placed in a gable-shaped pile about 5 feet wide and as long as convenient. A thin layer of straw should then be laid over the pile and this covered with 6 to 8 inches of earth. Another and thicker layer of straw and a final layer of earth will complete the work. Ventilators should be placed at intervals of 10 or 15 feet, which should be closed when sweating has ceased. The pit should not be opened on warm days in winter. A ditch for drainage should be cut around the pit. Roots stored in this way do not keep as well as when stored in a good cellar, therefore they should be fed out as early as possible.

A later bulletin (No. 244) of the New York Cornell Station giv in detail the best methods of growing different varieties of root cro for stock feeding.

CABBAGE AS STOCK FEED.[a]

In a recent bulletin of the New York Cornell Station S. Fraser say "In the search for good succulent feed for live stock, the cabba should not be overlooked. For this purpose the cabbage is to b compared with roots." It is stated that the only kind of cabbag grown in New York for stock feeding "is the common or headi cabbage, usually spoken of as 'cabbage,' and the one kind which understood when this term is used. The Savoy is used for st feeding in Europe, but not in America, so far as known to the write The cabbages, kales, turnips, rape, and kohl-rabi are closely relate * * * Among the kales practically none are grown in Ameri although the British farmer is extending his acreage of the thous headed cabbage or kale, and other forms are grown in parts Europe. That none of these latter are of value to this country hard seems possible and, no doubt, in time some will receive a fair tria

As high as 50 tons per acre of crop yielding nearly 4 tons of d matter containing about 1 ton of nitrogenous matter was obtai in the Cornell experiments. The essentials for a high yield are rational rotation to prevent the soil from becoming infected with club-root fungus, early planting to give time for full growth and development of the heads, and uniform stand of from seven to ten thousand plants per acre.

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[a] Compiled from New York Cornell Sta. Bul. 242.

The cabbage differs from almost every other farm crop in that its successful production is little influenced by the type of soil on which it is grown. It shows a wide range of soil adaptability and it can be grown on almost any type of soil provided it is well supplied with organic matter, is in good physical condition, and supplies an adequate amount of water. A loose friable soil well prepared by deep fall plowing and manured with 10 to 20 tons of barnyard manure per acre before plowing, followed by an application of 1,000 pounds of quicklime per acre after harrowing in the spring, is considered well adapted to large yields of cabbage.

The plants must never receive a check. Three or four days after transplanting or after thinning they should receive an application of 50 pounds of nitrate of soda per acre; this may be applied near the rows with a drill if feasible, or be sown broadcast and harrowed in at some time when the leaves of the plants are dry, for if they are wet and it dissolves on the leaves it will burn them. This application may be repeated twice more, at intervals of from ten or fourteen days, making a total application of 200 pounds of nitrate of soda per acre; even 300 pounds may frequently be used with profit. No crop will give better returns for such treatment and for clean and constant culture. The nitrate of soda aids leaf growth at a time when one green worm may eat a cabbage a day, and forces them through this critical period.

The following varieties were tested at the Cornell Station and all gave good results: Surehead, Volga, Autumn King, and Danish Ball.

Volga led in the proportion of head to total plant, and it kept better than Surehead or Autumn King. Autumn King seemed to be better suited to clay loam soil than gravel loam. Surehead did better than Autumn King in 1904 on gravel loam. Danish Ball is the lowest in yield, but has compact head. * * *

Cabbages are good food for cattle, sheep, and swine. When they are grown for stock feeding it has not been a general practice to remove them from the field. If it is convenient for feeding to continue into early winter they are pulled and piled closely, then fed directly from the field. When fed to sheep they are generally not cut. The sheep can nibble them very well. When fed to cattle they should be cut either by a cutting machine or they may be chopped fairly well with a square-pointed shovel. They should be fed as soon after being cut as possible. Sometimes the grain or chopped feed is mixed with them.

It is claimed by many feeders that cabbages are likely to lend a disagreeable odor or taste to the milk when fed to dairy cattle. This may be avoided, however, by feeding just before or just after milking, care being taken to remove the milk from the presence of the cabbage as soon as possible.

The following methods of storing the cabbage are described:

Method 1.—One of the simplest ways is to store in an orchard or some sheltered place, often alongside a fence which has been made tight by a liberal use of straw. The cabbage are stored with their stems on and are placed head down and as close together as possible. Two or three tiers are often made, the heads of the second tier being placed between the stems of the lower, and so on, the piles being made of any width and length desired. The whole is covered with leaves, salt-grass hay, or straw and a little soil, rails, brush, or litter. Small unsalable heads when stored in this way in November will continue to develop during winter and frequently sell as well as any in February.

Method 2.—Small quantities may be stored by plowing out two or three furrows, 10 or 12 inches deep, on a well-drained site, and placing the heads with their stems up as close together as possible. Some prefer to lay them but one or two thick, while others will pile them up 2 to 2½ feet high, bringing them to a point. The pile is then covered with straw, salt-grass hay, or a thin layer of straw, and then several inches of soil. They are stored before freezing, and when the soil covering them is frozen it may be covered with strawy manure or any other litter to keep the soil frozen until the cabbages are needed for sale.

Method 3.—Large quantities are stored in cabbage houses, this being the best way commercially for a large part of the State. The houses are often built alongside the railroad in order to facilitate shipment, but a small one can be built on the same principle if desired. The walls are frequently about 8 feet high at the eaves, built with three walls and two air spaces, papered on the outside, with a close-boarded and tar-papered roof. The building may be 50 feet wide and of any desired length, with a driveway through the center and well provided with ventilating arrangements. The building is divided into compartments or bins, which run across the house from the driveway to the wall, one on each side. These are 5 feet wide, made of slats on 4-inch studding. This permits of a 4-inch air space all round each bin, the end near the outside wall included. The floor of the bin is raised from the ground about 10 inches, and is also made of slats, thus securing free circulation of air. When the bins are filled, the driveway may be filled if desired. The heads are cut close, practically ready for shipment, and are piled in the bins from the floor to the ceiling. The filling is done in cold weather, if possible, and care is required in ventilating to keep the temperature of the building as near 30° to 35° F. as possible, opening during cool nights and keeping it closed on warm days or when cold snaps occur.

Method 4.—One or two carloads may be stored in the following manner: Select a dry site, excavate about 1½ feet deep and 9 feet wide and of the desired length. Set posts in each corner and every 4 or 5 feet along the side, letting them project about 4 feet above ground level. Board up the inside, 16-foot boards being useful. Set 2 by 4 inch rafters on the studding and roof with wide boards, lapping them a little. Cover the apex of the roof with two boards fastened together like an inverted V. Bank up the outside of the house, and in cold weather cover the roof with straw or horse manure.

PASTURING HOGS.[a]

In a bulletin of the Mississippi Station E. R. Lloyd discusses the subject of hog raising from the standpoint of Mississippi conditions, but states some facts which have a wider application, especially in the South. He points out that Mississippi now imports about 50 per cent of the pork consumed in the State, while with the facilities for producing cheap feed there should be an export of hog products.

There are some features in hog raising that should appeal to every thoughtful farmer. No other meat-producing animal is capable of producing so many young in a year. In our mild climate, where suitable pastures can be provided for nearly every month in the year, the sow should farrow twice annually, producing one litter in early spring which can easily be made ready for the late fall or early winter market, and another litter in early fall to be made ready for the spring market. The small amount of capital required to begin with and the quick returns on the investment should make hog raising especially attractive to the small farmer with limited means. The hog will make a pound of gain on less food than most live stock, and will profitably utilize the waste products around the farm, dairy, and kitchen.

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[a] Compiled from Mississippi Sta. Bul. 100. See also U. S. Dept. Agr., Farmers' Buls. 56, p. 6; 84, p. 18; 124, p. 25; and 276, p. 20.

At present there is a strong demand at very attractive prices for what is known as the light market hog, weighing from 130 to 150 pounds. A hog of this weight can easily be produced with ordinary care at from 4 to 6 months old.

No man should attempt to raise hogs without adequate pastures. For pastures woven wire is the best fencing material, all things considered. Around the field to be used for pasture run a woven-wire fence 30 inches high with three strands of barbed wire above. This fence will not only turn hogs but other live stock.

For convenience in preparing the land and planting the crops, it is best not to divide the pasture up with permanent fences. When the crops are ready for the hogs, by using the hurdle or portable fence the field may be divided into lots of any size. The hurdle fence is simple and cheaply made, and when not in use can be taken down and stored under a shed until needed again.[a]

There is a mistaken idea held by some that alfalfa, red clover, rape, and similar crops will produce profitable gains when pastured without grain. The practical trials made at many experiment stations prove this not true. Of the many forage plants, alfalfa is one of the most satisfactory for hogs, since it can be made a permanent pasture and is rich in protein, making an excellent combination with corn. The leaves are tender and the stem small, which make it easily masticated and it is very much relished.

At the Mississippi Station careful tests have been made to determine the value of alfalfa pasture without grain for hogs. Pigs ranging in age from 3 to 24 months have been used, and the results of two years' work show that alfalfa is little more than a maintenance ration for growing hogs without grain. Satisfactory gains have always been secured from alfalfa pastures by supplementing the pasture with from 1 to 2 per cent of the weight of the hogs in corn or other grain.

Cowpeas without grain so far have given better results than any other crop for hog pasture. In one test the crop was grown on thin hill land, where 1 acre of cowpeas produced 350 pounds of pork. In another test on rich valley land 1 acre of cowpeas produced 483 pounds of pork. The hogs were put in the field when the peas were about ripe.

CULL BEANS AS A FEED FOR HOGS.[b]

Beans are a very important agricultural crop in Michigan, the total crop ranging between 1,500,000 and 5,000,000 bushels per year. It has been estimated that from 5 to 10 per cent of the total crop consists of culls or damaged beans, the proportion being influenced by the peculiarities of the season and weather conditions at the time of harvest. Of these cull beans about one-half are probably used for feeding purposes.

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[a] For construction of hurdles, see U. S. Dept. Agr., Farmers' Bul. 78, p. 12.

[b] Compiled from Michigan Sta. Bul. 243.

R. S. Shaw and A. C. Anderson, of the Michigan Experiment Station, who have recently studied the value of cull beans as a feed for young pigs and for fattening pigs, state that—

> Mixed with other grains, cull beans may be fed to sheep, and large quantiti are used in this State for this purpose each year. It is reported that they ar used as a food for dairy cows; they are also fed to swine. * * *
>
> It is not desired to advocate the extensive use of beans as a swine fo especially in the fattening or finishing period. Pork from hogs which have b fattened quite largely on beans is generally soft and lacking in quality. If considerable portion of the pork produced in the State were of this kind it woul lower prices and work serious harm to the swine industry. It is generally co ceded that bean-fed hogs store up a fat having a lower melting point, and co quently a softer fat, than hogs fed upon many other feeds, and that a consid able portion of the element called quality in pork is dependent upon the mel point or character of the fat stored up.
>
> In the case of mutton finished upon beans no such criticism has been ma probably because there is relatively less fat in the carcass of the sheep, and character is not so essential to the quality of the meat as in the case of the

In the Michigan experiments the cull beans used were cooked two ways: "The one by injecting live steam into a barrel contain the food to be cooked, the other by the use of the ordinary feed cook consisting of a caldron kettle, with a cast-iron stove as a jacket the same. A large variety of cookers of similar sorts are upon market. In cooking small amounts, the kettle gave the better res while the steam was more convenient for larger quantities."

When cooked beans mixed with corn meal in the proportion of were fed for ten weeks to pigs weighing on an average 50 pou there was an average daily gain of 0.95 pound per head at a co 2.8 cents per pound. "It was apparent that the food combina while it possessed the proper amounts of carbohydrates and pro was not well enough adapted to the requirements of the pigs to p duce adequate growth. It was thought that the introduction of a concentrated food factor would give variety to the ration, and at a physical composition better suited to the age and digestive po of the pigs." Accordingly, middlings were substituted for a par the beans in a trial made with two lots of five similar pigs weig on an average 73 pounds, and covering ten weeks, the ration con ing of cooked beans, corn meal, and middlings 2:3:2. The av daily gain was 1.34 pounds per head per day, and the cost of a p of gain 3.1 cents.

Check tests made with two lots of similar pigs fed a ration of skim milk and corn meal 5:1 showed an average daily gain of pounds per head at a cost of 3.7 cents per pound of gain.

When cooked beans alone and mixed with corn meal 1:1 were pared with pigs averaging 150 pounds in weight, three lots fed b only made in eight weeks an average daily gain of 1.1 pound head, 4.21 pounds of beans at a cost of 2.53 cents being required per pound of gain. On beans and corn meal the average daily gain was 1.52 pounds and the cost of a pound of gain 3.25 cents, 4.1 pounds of the bean and corn meal mixture being required per pound of gain.

It would appear that hogs of the weights and ages of those fed in this experiment could reasonably be expected to make a gain of about a pound per day on a ration consisting of beans only, and that the same sort of hog could reasonably be expected to make a gain of about 1½ pounds per day if an equal amount of corn were supplied with the bean ration. Further, it would appear that the gains made by the bean-fed hogs would cost about $2.50 per hundred pounds and those made by the beans and corn-fed hogs would cost about $3.50 per hundredweight.

If the cost of the additional labor and equipment is eliminated the gains made from the beans alone were cheap, but other factors must be taken into account and, when judged by experts, the bean-fed pigs were rated as being worth less per pound than those fed the beans and corn meal.

The general conclusion from the investigation seems to be that cull beans rightly used may be a valuable factor in pig feeding, but that excessive amounts should not be fed, as beans have a tendency to produce soft pork.

From many inquiries and reports received from the farmers of the State it was known that many were using beans alone for fattening swine. Some of these told of large gains and others of unsatisfactory ones. Some that had corn were even selling this and buying damaged beans, feeding these exclusively instead of making a combination of the two feeds. Such feeding must necessarily be accompanied with some losses of protein, and from the standpoint of food economy is open to considerable criticism. However, if the beans were cheap the practice might be financially allowable. When any feed is cheap and a large stock of it is on hand there is a great temptation to supply it too freely, and to feed it to the exclusion of other feeds which experience and judgment would suggest.

As regards methods of feeding beans, Professors Shaw and Anderson state that—

> Beans can be fed to swine only in the cooked form. The pig seems to be unable to utilize beans which are at all hard or firm, even though they have been boiled for some time, hence it is very essential that they be thoroughly [and carefully] cooked. To supply a single feed of half-cooked beans to a pen of hogs robs them of their appetites and relish for their food, if indeed it does not put them off feed. * * *
>
> The amount of water used will be governed somewhat by the way the beans are to be fed, whether they are to be mixed with other feeds or fed alone. In either case the water content of the ration should not be above the bodily requirement of the pigs fed. In fact, it is usually better to have the water content of the ration below the daily requirement of the pig and then allow the pig access to water at will or supply it regularly. When the food is excessively sloppy, the pig is compelled to consume unnaturally large amounts of the ration given in order to properly supply his bodily needs. This distends the stomach,

unbalances the whole digestive system, and makes a paunchy, ill-formed pig, and one which at slaughtering time yields a very low per cent of dressed carcass. Such feeding is neither good practice nor good economy. * * * All refuse grains contain more or less foreign material. Cull beans are no exception to the general rule, perhaps the most objectionable ingredient being the gravel stones. In some samples there was from 5 to 10 per cent of gravel stones. * * *

By the use of a hand fanning mill adapted for bean cleaning a considerable portion of the stones may be eliminated. * * *.

It will be found advantageous to use some salt with every mess of beans cooked; about the same amount as would be used for human food would probably be sufficient [but it must be remembered that an excessive amount of salt may cause serious disturbance].

Salt is an appetizer and renders the food more palatable. It also possesses laxative properties, and on this account will be found valuable to use in connection with any ration containing beans. * * *

It is a general rule in all feeding operations that when any change is to be made in the ration of an animal it should be done gradually. This is especially applicable in the use of a ration containing any large quantity of beans.

In winter feeding it will be advisable to supply the feed while warm, but in the use of all warm feeds every pailful used should be stirred until at an even temperature and then tested with the finger. It is a cruel neglect to supply hot food to a hungry pig. Sore mouths, dislike of food, and apparent loss of appetite are sometimes traceable to no other cause. Such mistakes will sometimes occur unless the feeder adopts the plan of stirring and testing every pailful fed.

Pails used should be rinsed after each feeding, and especial care should be taken to clean the kettle or barrel after each cooking and not allow sour or moldy material to collect about the food receptacle.

HEALTHY POULTRY.[a]

Dr. C. A. Cary, of the Alabama College Station, makes the fo lowing suggestions regarding the maintenance of sanitary conditi in poultry raising and the treatment of certain common poultr troubles, which it is believed will be useful to those who are engag in the business on either a large or a small scale. Pure water a wholesome feed are of course prime requisites. Of the first, Do Cary says:

Water.—The water supply for poultry should be the very best. Fresh wa in clean, uncontaminated vessels should be kept constantly within reach of chickens, or all kinds of poultry, especially during the hot weather. Good w water is preferable to running surface water. Protected earthen-ware ve or any form of water vessel should be so constructed that it can be cleaned fact, it should be cleaned daily with boiling hot water.

The relation of the feed to health is thus explained:

Feed.—The feed is responsible for the health, growth, and flesh of p Young chicks are often overfed and usually fed in filthy places or in u troughs or vessels. More young chicks die from overfeeding and sour, fer ing, decomposing feed than from any other cause. Especially is this true a mashes or liquid or moist feed is used. Some poultrymen use milk with bread or coarse meal in it. Milk is a good food, but if given to chickens it must be fresh or it should be boiled or cooked with the bread or meal in it and fed as soon as sufficiently cooled. Always feed it in clean vessels, not in too large quantities, and never leave the excess to sour. In feeding milk and all forms of moist feeds to chickens be sure to thoroughly clean and boil or scald out the feeding vessels once or twice per day during hot weather. Look well to the chick feeds. Many of them are made of refuse corn, wheat, sorghum, and other grains. As a rule it is best to make your own mixed grain feeds, and then you will know the quality of each grain ingredient and will not be compelled to pay grain prices for the heavy grit that is so plentiful in the average mixed chicken feed. It is cheapest and safest and best for the health and growth of the chickens or other fowls to buy the separate grains and the grit and do your own mixing.

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[a] Compiled from Alabama College Sta. Bul. 136.

The arrangement and management of the poultry houses and yards are shown to have a most important bearing upon the health of the occupants.

Arrangement and management of houses, yards, etc.—The chicken houses should be separated from all other buildings, and all the sides should be of lattice work or quite open during the summer. The north, east, and west may be closed during late fall and winter. The floors, roosts, and nests should be so arranged as to be readily removed, cleaned, and disinfected. Portable or movable chicken houses are useful if so built that they will not come to pieces when moved. In cases of infection with disease germs, or of infestation with mites, intestinal parasites, lice, etc., it makes the work of disinfection and eradication of parasites more easily and quickly and permanently done if the house can be quickly moved to a new uninfected locality.

Most chicken coops are too close, too heavy, and too inconvenient to clean. Some one should invent a "knock-down" brooding coop that can be cleaned readily, and one that will not easily break, and retain firmness and solidity when set up.

The yards and runs are usually too small and insufficient in number. Poultrymen can greatly lessen their work by having large yards or runs and many of them.

The placing of 20 to 40 chickens in a small yard (say 50 by 100 feet) and keeping them there eight to twelve months in a year is one of the means of intensifying the propagation of intestinal parasites of all kinds. The degree of infestation of a yard or run or poultry house depends upon the size, the number of poultry kept in them, the length of time poultry are kept in them, and, to some extent, on weather conditions. A large area, as a yard or pen, will not become alarmingly infested with intestinal or other parasites as quickly as a small area. Likewise, the fewer the birds and the shorter the time the birds are kept in a given place, the less, in degree, the infestation. This often explains why a man with very few chickens having good feed and wide range can raise fine, healthy birds. But when this same man attempts to raise a large number on a small range, yard, or run, he fails, and his chickens are less vigorous or healthy and consequently less profitable. The number of houses, coops, yards, and runs should always be in excess of the immediate demands. Suppose a man has yards, runs, houses, and coops for three different lots of chickens. He should at least have three extra yards and runs into which he could shift the disinfected houses, coops, and birds as soon as the other yards or runs became infested. It would be best to have yards and runs sufficient in number to enable the poultryman to make three or four shifts before coming around or back to the first. This may seem extravagant, but it is the only means by which you can breed healthy, vigorous birds without an immense outlay in cleaning and disinfecting yards or runs. Immediately after vacating a yard or run, plow it up and seed it down to wheat, rye, oats, barley, cowpeas, sorghum, or anything that will make a growth upon which the chickens can graze when brought back to this yard or run. Young chickens should not be allowed to range over ground where old chickens run; if it be possible, have the young chicks in a pen or yard where no old chickens have been for six or eight months. This will prevent young chicks from becoming infested with roundworms and tapeworms.

Doctor Cary recommends that when new fowls are purchased they should be confined in some place remote from the flock for one to four weeks. This will give time to determine the presence or absence of such an infectious disease as fowl cholera, a precaution which may save the flock and avoid the difficulty of disinfecting houses and yards.

In spite of great care and strict observance of the precautions enumerated, however, insect pests and diseases may get into the flock and remedial treatment becomes necessary.

Insect pests and diseases.—Chicken mites are the most common pests in nests and houses. Cleanliness is the best means of preventing their multiplication. They develop best in filthy nests and in cracks and under boards in chicken house. Clean the house (move if portable) and then spray the house with kerosene oil emulsion. If possible apply tar in cracks and under roosting boards and this will catch many which escape the spray. Clean and spray the infested houses and coops once per week and dip the infested chickens in weak kerosene oil emulsion, or a 2 to 4 per cent creolin solution. Never dip chickens in a poorly mixed kerosene solution. It will blister the skin, if the kerosene is not thoroughly emulsified. Copper sulphate solution, if applied hot [to roosts, walls, etc.], will kill mites. It should not be applied on the chickens.

The following directions are given for the preparation of the kerosene emulsion and copper sulphate solution needed for the treatment recommended:

Kerosene emulsion.—Dissolve one-half pound of hard soap in 1 gallon of h water, add 2 gallons of kerosene and stir or churn until a milky mixture (emulsion) is formed; now add 8 to 10 gallons of water; stir or mix with a s pump, or keep the first emulsion of soap, water, and kerosene and use as m of it as you desire after diluting with 8 to 10 parts of water.

Copper sulphate solution.—Dissolve 4 to 6 pounds of copper sulphate (b stone) in 20 to 50 gallons of water. Spray this over dusted or cleaned b walls, nests, or other places. When dry, or the next day, whitewash with or brush. If applied hot this copper sulphate solution will kill mites.

Whitewash is used to a large extent in connection with pou houses, and is an efficient means of filling small cracks and mak smooth surfaces which can not harbor vermin. An excellent wash this purpose is the so-called Government whitewash, which is p pared as follows:

Government whitewash.—Half a bushel of unslaked lime, slaked with warm water. Cover it during the process to keep the steam. Strain the liquid through a fine sieve or strainer. Add a peck of salt previously well dissolved in warm water, 3 pounds of ground rice boiled to a thin paste, and stir in boiling hot a half pound of powdered Spanish whiting (plaster of Paris) and a pound of glue which has been previously dissolved over a slow fire, and add 5 gallons of hot water to the mixture. Stir well and let it stand for a few days. Cover up from dirt. It should be put on hot. One pint of the mixture will cover a square yard if properly applied. Small brushes are best. There is nothing that compares with it for outside or inside work, and it retains its brilliancy for many years. Coloring may be put into it and made of any shade, Spanish brown, yellow, or common clay. To it may be added 2 pints of carbolic acid, which will make it a disinfectant.

Doctor Cary gives the following useful list of drugs needed by the poultryman and suggestions as to their uses:

FOR INTESTINAL WORMS.

(1) Isolate infested birds and destroy or disinfect their droppings while being treated.

(2) Put 1 to 2 drams of copper sulphate in each gallon of drinking water for one week; or

(3) Powdered pomegranate root bark (for tapeworms), followed by 2 or 3 tablespoonfuls of castor oil; or

(4) Oil of turpentine, 1 to 2 teaspoonfuls, followed in four to six hours with castor oil.

(5) Powdered santonin in 5 to 8 grain doses is especially good for roundworms.

(6) Chopped-up pumpkin seed for tapeworms.

FOR WORMS IN THE AIR PASSAGES.[a]

(1) Turpentine introduced by stripped feather into the windpipe.
(2) Steaming with creolin and turpentine in the hot water.
(3) Feeding garlic in the food.

FOR DIARRHEA.

(1) Subnitrate of bismuth, 1 to 4 grains, two to three times per day; or
(2) Pulverized chinchona bark, 1 to 2 grains three times per day, and
(3) Quinine one-eighth to one-half grain two times per day.
(4) Dry feed or cooked and slightly moist feed.

CONSTIPATION.

(1) Epsom salts, 20 to 30 grains in 1 tablespoonful of water; or
(2) Castor oil, 1 to 2 teaspoonfuls; or
(3) Calomel, 1 to 2 grains, and
(4) Soft feed.

FOR LICE.

(1) Lard or vaseline over head, under wings, and around anus.
(2) Dipping in 15 per cent kerosene-oil emulsion; or
(3) Dipping in 2 to 5 per cent creolin solution.
(4) Pyrethrum powder dusted among the feathers.
(5) Clean nests, yards, and houses.

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[a] U. S. Dept. Agr., Farmers' Bul. 84, p. 28.

FOR INTESTINAL DISINFECTANT.

(1) One-half to 2 drams of copper sulphate in 1 gallon of drinking water; or
(2) One-half to 2 drams of iron sulphate in 1 gallon of drinking water; or
(3) Salol, one-half to 1 grain, once or twice daily.
(4) Naphthol, one-half to 1 grain, once per day after eating.
(5) Resorcin, one-fourth to one-half grain, once per day after eating.
(6) Hyposulphite of soda, 4 to 10 grains in 1 tablespoonful of water.

FOR CHICKEN MITES.[a]

(1) Lard or vaseline on legs, feet, and head applied once or twice per week. Wash off scales.

(2) Kerosene emulsion sprayed on walls, roosts, floors, and nests once per week for what is commonly called chicken mites or chicken ticks.

(3) Two to 5 per cent creolin solution sprayed on same places as (2).

(4) Formalin, 1 part to 200 parts of water, sprayed as (2).

(5) Corrosive sublimate (very poisonous), 1 part to 1,000 parts of water, sprayed as (2).

(6) Boiling hot water freely applied by pouring over walls, roosts, nests, and floor.

(7) Clean chicken house every day until mites are gone.

Doctor Cary recommends that every farmer and poultryman should take one or more good poultry journals and should get all the publications on poultry issued by this Department and by the State experiment stations.

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[a] U. S. Dept. Agr., Farmers' Bul. 190, p. 6.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 306.

DODDER IN RELATION TO FARM SEEDS.

BY

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GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., July 1, 1907.

SIR: I have the honor to transmit herewith a paper by Mr. F. H Hillman, Assistant Botanist in the Seed Laboratory, entitled "Dodder in Relation to Farm Seeds."

Dodder, on account of its parasitic nature, is the most danger weed in alfalfa and clover fields, and also often affects flax. On accou of the large quantity of low-grade seed containing dodder importe from Europe and the prevalence of dodder in the alfalfa-growin regions of the West, its seed is becoming more and more commo commercial seeds.

In this paper an attempt has been made to point out the danger character of the various kinds of dodder and to give practical sugg tions for the eradication of dodder from infested areas.

I recommend that this paper be published as a Farmers' Bullet

Respectfully,

B. T. GALLOWAY,
Chief of Bur

Hon. JAMES WILSON,
Secretary of Agriculture.

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DODDER IN RELATION TO FARM SEEDS.

INTRODUCTION.

It is probable that commercial seeds representing forage crops, especially the clovers and grasses, are the most effective medium through which weed seeds are disseminated. The custom in vogue in this country and in foreign countries of producing seed of these crops as a secondary feature of their culture and without special attention to the character of the foreign plants which may grow with the crops is chiefly responsible for the great number and variety of weed seed impurities commonly disseminated in the product. Such foreign seeds are characterized primarily by ripening at about the same time as the crop, and as they possess a similarity to the crop seeds in size and weight they are not readily removed by the sifting accompanying the thrashing of the crop. It is in this way as incidental to the culture of certain crops that the seed of dodder or love vine becomes an impurity of certain kinds of commercial seed.

Dodder is not in itself a means of direct seed adulteration, but as a very common impurity of low-grade seed it becomes a prominent feature of adulteration when such seed is used as the adulterant.

Dodder, especially as a menace to clover and alfalfa culture, is becoming more and more prevalent throughout the country and is everywhere commanding attention from farmers who are observant of conditions affecting their crops.

The most important step in controlling the dodders is to prevent, if possible, the introduction of their seeds in commercial seed. While absolute freedom from dodder in farm seed can not be assured, proper care on the part of the purchaser can reduce to a minimum he chances of dodder introduction. This involves the recognition of he dodder if present in seed and the recleaning or rejection of the atter, as the case may require.

The farmer should know what crops are liable to damage from odder, to what extent their seeds carry dodder seed, that several inds of dodder are involved, that the source of the crop seed nfluences the kind of dodder likely to be present, that dodders have ery pronounced host preferences, that dodder seed production may influenced by climatic conditions, etc.

DODDER AN IMPORTANT IMPURITY IN SEEDS.

The seed of dodder becomes an important impurity of commercial seeds both on account of the injurious nature of the plants and the fact that they occur in nearly all the regions where clover, alfalfa, and flax seeds are produced. The size and weight of the dodder seeds and the period of their maturity agree so closely with those of red clover and alfalfa seeds that their presence in the seed crop is practically sure to follow the occurrence of maturing dodder plants in fields devoted to these crops. The same is true of flax seed which has not been especially well cleaned. The extent to which dodder may infest clover and alfalfa seed is indicated by the fact that of 521 samples of red clover seed secured by the Seed Laboratory in the open market i the spring of 1906, 116 samples contained dodder. Again, of samples of alfalfa seed 160 contained dodder.

Clover and alfalfa seeds as sold to farmers have frequently followed a devious course from the grower to the consumer and are especially likely to represent a mixture of lots from different places of production. If one ingredient of such a mixture is infested with dodder the whole becomes contaminated. Not many dodder seeds may occur in a particular lot bought by a farmer, to be sure, but owing to the peculiar nature of the dodder plants a single live dodder seed in a field is a menace to the entire crop.

It is very important that the farmer purchasing clover, alfalfa, or flax seed be qualified to determine for himself whether dodder is present, because it usually is not conspicuously abundant and may escape the notice even of the most conscientious dealer.

SENTIMENT REGARDING DODDER IN EUROPE.

The dangerous character of the dodder plants as pests of flax a leguminous crops, together with their wide distribution throug the regions which have long grown these crops, especially in Europ has caused them to be looked upon with dread by farmers. T result is that under the existing seed-control regulations generall vogue in Europe dodder seed as an impurity of commercial seed singled out for special consideration and seed containing it is usua rejected. Reports upon seed tests at the European seed-control tions usually make particular reference to the presence or absen dodder. As a result of its unpopularity seed containing it is practi unsalable in the domestic trade of most of the European countrie

It is owing to this adverse sentiment in Europe regarding dod infested seed and the absence in this country of a national law pr iting the importation and sale of such seed that so much dod annually distributed throughout the United States.

THE CHARACTER OF DODDER PLANTS.

Dodder is a parasite deriving its food not from the soil, but directly from the crop plants which it infests. In this respect it is unlike the ordinary weeds of the farm. It starts from a seed, at first deriving its nourishment from the food supply stored within the seed. During this period it develops a slender, threadlike, and leafless stem. It is the habit of the dodder to climb by twining, and the young stem sways about in search of a support. Failing to find a suitable support it dies when the food stored within the seed is exhausted. If a suitable support, such as the stem, leaf stems, or even leaf blades of a clover, is found, the dodder rapidly twines about it, sending out from its stem numerous suckers which penetrate the tissues of the plant upon which it rests, termed the host plant. The dodder is subsequently dependent on its host for both its mechanical support and its food supply. The twining of the dodder stem and the clinging effect of the suckers secure the mechanical support necessary, while the penetration of the suckers to the sap-conveying tissues of the host plant insures direct communication with the food prepared by the latter for its own use.

After becoming established on the host plant the part of the dodder plant below the point of attachment dies. Above this point the plant makes rapid growth, branching repeatedly, its branches ultimately forming a tangled mass of threadlike filaments when under conditions favorable for luxuriant growth. At first the growth is apparently insignificant, but with the rapid increase in the branching the total growth soon becomes very conspicuous, and in some instances progresses with exceptional rapidity, rendering its control very difficult.

Dodder depends on prepared food. Independent food manufacture becomes unnecessary, and consequently the plant is devoid of leaves, as well as of root, and usually is devoid of the green color common to other plants. Certain species are strongly tinged with green, however, and doubtless are capable of food production to some extent.

Sections of the dodder stems removed from the main plant retain their vitality and power of coiling and producing suckers for several days at least under favorable conditions. In consequence of this, if pieces of plants are allowed to remain in contact with a suitable host plant for a short time they become attached to the latter and form new centers of growth. In this way new patches of the pest may become established in the field.

Dodder plants are to be distinguished by their slender, threadlike stems, which are lemon yellow, orange, or pink. They may appear to confine their attack to a single plant in a place or may spread uniformly from plant to plant, either near the ground or from the tops of the plants. Small white flowers, mostly in clusters, are produced by midsummer. The flowers may be few and scattered, or, owing to thrifty growth, they may be more numerous and, becoming crowded, form dense bunches. (Fig. 1.)

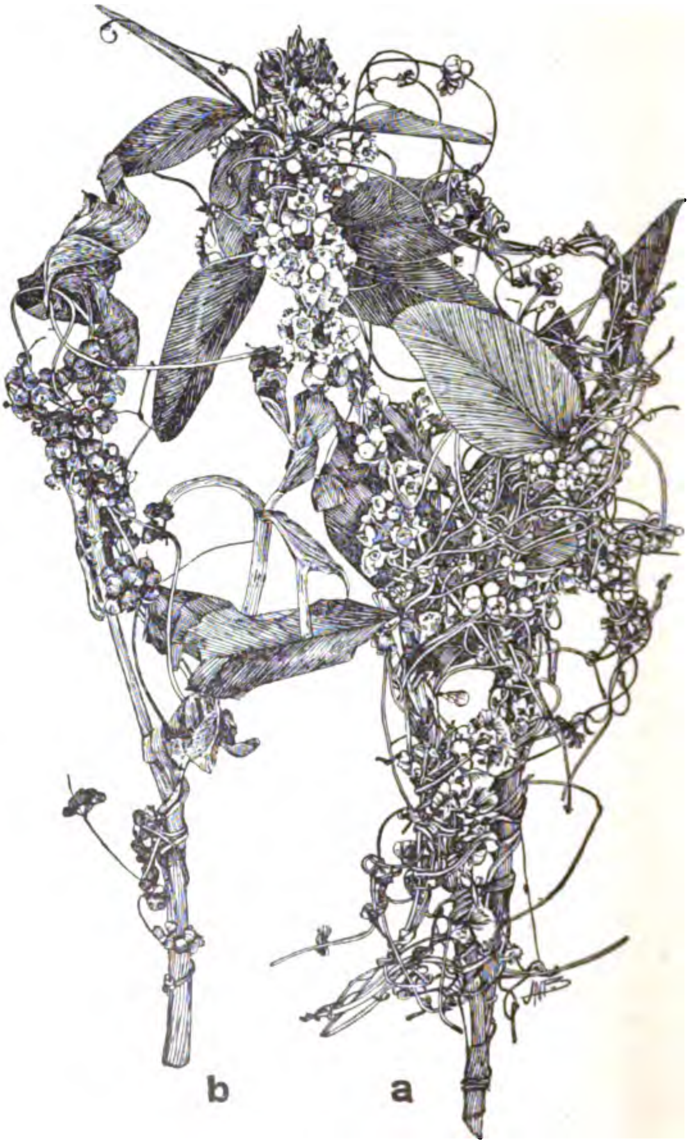

FIG. 1.—Field dodder on red clover; *a*, Flowering cluster; *b*, cluster of dry seed vessels. From a graph. Natural size.

Seeds ripen throughout the central United States from the mi of July into September. As a rule, the dodders are profuse producers, but seed production is strongly influenced by the char of the host, its treatment as a crop, and by the condition of the weather during the flowering season of the dodder.

THE VARIOUS KINDS OF DODDER.

Farmers commonly look upon dodder as representing but one kind of plant. On the contrary, there are several kinds which infest leguminous crops, irrespective of the kind infesting flax. This discussion relates in the main to the class of dodders whose seeds are carried by commercial seeds, but it may be said that there are other kinds indigenous to certain parts of the country which are more or less injurious. These kinds attack certain cultivated plants which may be brought near them. If the seeds of such cultivated plants are not in the trade, the dissemination of the dodders affecting them is accomplished by the transmission of plants or cuttings bearing living pieces of the dodder.

As a matter of passing interest, it may be stated that aside from the injurious kinds of dodder there is a large number of kinds which have no recognized relation to cultivated plants or crops. They live on various wild plants, and it is the common experience of those who frequent fields and uncultivated lands to meet one or more of these kinds of dodder which command the attention of the most unobserving person by their peculiar threadlike, tangled stems.

KINDS OF DODDER SEED INFESTING FARM SEED.

There are at least six different kinds of dodder whose seeds are commonly disseminated in commercial seeds and therefore are worthy of the farmer's consideration, as follows:

(1) Flax dodder (*Cuscuta epilinum*) is a parasite on flax especially. It sometimes infests other plants, including certain shrub fruits, but it is not a pest of clover or alfalfa fields. It occurs in foreign countries and also in those States where flax is grown in this country. The other kinds of dodder under discussion are all parasites on clover or alfalfa, or on both, but do not infest flax.

(2) Clover dodder (*Cuscuta epithymum*, often referred to as *Cuscuta trifolii*) infests both the true clovers and alfalfa indiscriminately. It is widely distributed in foreign countries and in the United States east of the Mississippi River and in the Northern Pacific States.

(3) Small-seeded alfalfa dodder (*Cuscuta planiflora*) as it occurs in this country appears to confine its attacks to alfalfa in preference to the true clovers. Thus far there is no evidence of any damage from this dodder to red, alsike, or white clovers. This is by far the most abundant and destructive of the dodders in the Western States.

(4) Field dodder (*Cuscuta arvensis*, as recognized in the botanies) is widely distributed throughout the United States. It infests both the

clovers and alfalfa and also many wild herbaceous plants. It has proved injurious to sugar beets in Utah.

(5) Large-seeded alfalfa dodder (*Cuscuta indecora*) is common in the West, especially in Utah. It infests alfalfa as well as various wild plants, but it does not appear to damage the true clovers.

(6) Chilean dodder (*Cuscuta racemosa chileana*) is not generally known in this country. It is common in South America and has been reported from Europe. It is said to have flourished for a time in California many years ago, but subsequently disappeared. It is of interest because of its prevalence in alfalfa and red clover seed-producing regions of South America from which seed is being sent to the United States, for this dodder infests both alfalfa and red clover. Little is known of this dodder in its relation to forage crops in this country, but since it is being brought here in considerable quantity from South America it is very likely that it will become one of the several injurious species established in the United States.

PREFERENCE OF THE DODDERS FOR CERTAIN HOST PLANTS.

The dodders exhibit a peculiar preference, so to speak, for certain plants over others as hosts. It is more evident with some dodders than with others, and in consequence certain kinds have come to be popularly designated in accordance with this evident preference. This fact has been so long recognized that in some instances the Latin names were selected with regard to it. Thus the dodder universally attacking flax is known as flax dodder in several languages, and its habit of infesting the flax crop is expressed in its Latin name *Cuscuta epilinum*, since flax belongs to the botanical genus Linum. Another kind known thoughout Europe and in this country as clover dodder has been generally recognized by botanists under the Latin name *Cuscuta trifolii*, given to it in recognition of its preference for the true clovers, which belong to the genus Trifolium.

This host preference becomes of interest from a practical standpoint from the fact that certain classes or kinds of crops are subject to infestation, while others are not. Thus, of the forage crops the leguminous plants are infested, while the grasses are not affected, to a material extent at least.

Notwithstanding this more or less decided selective power exhibited by the dodders toward host plants, they will attack other kinds of plants under favorable conditions and for a time derive their nourishment from them. They are very likely not to thrive, however, and often do not produce flowers and develop seeds when on such hosts. Clover dodder, for instance, will be found growing on various grasses and weeds among the clover plants of a field, yet when the clover succumbs to the dodder such grasses and weeds begin to thrive, the dodder they have supported largely or wholly disappearing. On the other hand, the small-seeded alfalfa dodder of the West confines its attacks almost exclusively to alfalfa, other plants in the field as a rule being immune to it. Field dodder is more indiscriminate in its preferences. While it grows actively on various wild plants throughout the country, it is a most luxuriant and destructive pest of both clover and alfalfa.

KINDS OF SEEDS INFESTED WITH DODDER.

The host preference possessed by the dodders limits both the kinds of seeds which carry dodder seed and the kinds of dodder disseminated in this way. Both are further limited by the relative sizes of the seeds of the host and of the dodder.

Dodder seed dissemination as a seed impurity is practically restricted to the seeds of flax and of leguminous crops or to seed mixtures in which leguminous seed forms an ingredient. Most of the leguminous crops may be subject to dodder infestation, but it is confined chiefly to those whose period of ripening coincides with that of the dodder and whose seeds are small enough to admit the dodder seeds as an impurity. This restricts the list of seeds for this country to flax, the red clovers, alsike clover, white clover, and alfalfa. To these may be added yellow trefoil, which as an adulterant frequently used may introduce dodder to otherwise dodder-free clover or alfalfa.

The list of leguminous seeds mentioned as subject to dodder infestation is given because tests of these seeds have shown that dodder is at least sometimes present in all of them. The source of the seed at once becomes important in this connection, because American-grown alsike and white clover seeds rarely, if ever, contain dodder, while those produced in Europe often contain it. Again, the place of production of red clover and alfalfa seeds has a most important bearing on the probability of the presence of dodder seed, its kind and quantity. Dodder as a seed impurity becomes from a practical tandpoint of most interest to the American farmer in its relation to ed clover, including the mammoth variety, and to alfalfa. With egard to these kinds of seeds the presence of dodder becomes a serious matter and in the purchase of seed is always worthy of careful conideration.

RELATION OF DODDER TO THE SEED TRADE.

The most direct relation between dodder seed and the business of seed buying and selling is based upon the regions of growth of the dodder and the size of its seed as compared with that of the commeral seeds handled. The kind of dodder is largely influenced by the lace of seed production, while the size of the dodder seed, which is dependent chiefly on the kind, has much to do with the result of efforts at recleaning and the consequent condition of the seed when it reaches the consumer. Large quantities of the flax, clover, and alfalfa seeds on the American market are imported, often from regions where certain kinds of dodder are abundant.

REGIONS OF SEED PRODUCTION.

With regard to flax seed little is to be said of the relation of the place of production and flax dodder. This dodder is so widely prevalent in flax regions that its presence in flax seed is always possible.

Red clover seed is imported largely from Germany and to some extent from France, England, and Canada. Chilean red clover seed grown in South America is being imported in considerable quantity. There is also an active domestic traffic in red clover.

Alsike clover seed when imported comes chiefly from Ontario, very little being imported from Europe. It is also produced in the northern United States.

White clover is often imported from Europe, but is also produced in this country.

Crimson clover, which figures largely in the import as well as the domestic trade, bears practically no relation to dodder dissemination when not adulterated, owing to its early seeding period, which precedes that of the dodders by a month or more. Dodder seed, therefore, practically never appears in pure crimson clover seed.

Alfalfa seed is imported from Germany, southern France, Italy, Turkestan, and Argentina. Much of the seed used in this country is produced in the Western States, particularly Utah, Wyoming, and Colorado.

Seed reaching the consumer may have come from any one of the regions just mentioned, or, if mixing the seed is practiced by the dealer, more than one region of production may be represented by the seed purchased.

Clover dodder is so widely distributed that it is liable to appear in clover or alfalfa seed from almost any source. It is commonest, however, in seed from Europe. This dodder grows in Canada; but little, if any, clover dodder is found in Canadian seed of red clover or alsike clover. While it is known that this species of dodder produces seed in this country to some extent, the fact remains that very little, if any, of its seed appears in American-grown clover or alfalfa seed.

Small-seeded alfalfa dodder is very common throughout the alfalfa-producing States of the West. It often totally destroys fields of alfalfa, while others continue to produce hay and seed for a long time after becoming infested. So abundant is this dodder in some cases that the seed crop, according to statements made to the writer ranchers in Utah, often contains from 10 to 20 per cent of dodder seed. This is mostly removed from the alfalfa before it is marketed. One farmer producing large crops of alfalfa seed in Weber Valley, Utah, told the writer that he obtained 60 bushels of dodder seed by recleaning his alfalfa-seed crop for 1904. The condition of his own and the neighboring fields gave excellent support to his statement.

The native home of this alfalfa dodder is in the region of the Mediterranean Sea. Comparatively little alfalfa seed comes to America from the Mediterranean region of Europe, so this dodder is rarely, if ever, found in European alfalfa seed; neither has it been found in South American seed. Turkestan alfalfa seed often contains the seeds of a dodder which appears to be a form of this species.

Field dodder is widely distributed within the United States and its seed is a common impurity of both red clover and alfalfa of domestic production. This dodder is supposed to be an indigenous species, but owing to the fact that much clover and alfalfa seed produced here is exported to foreign countries it is probable that seed of this species is now coming back to us in imported seed. Unless another very similar species of dodder be involved it may be said that field dodder is a common impurity of red clover and alfalfa seeds from nearly all places of production, including the Chilean seed from South America.

Large-seeded alfalfa dodder is found thus far exclusively in alfalfa seed from the western United States, particularly Utah. It does not appear in seed from Europe, although it might be looked for in seed from France, where it is probably the species said to have come from the United States and which is referred to as *Cuscuta gronovii.*

Chilean dodder is common in red clover and alfalfa seeds from Chile and Argentina. It is not known that its seeds occur in domestic-grown seed.

COMPARATIVE SIZES OF SEEDS.

Seeds of the same kind of dodder always differ somewhat in size. The difference is more pronounced in some kinds than in others. There is a more marked difference, however, in the average size of the seeds of different kinds.

While there is similarity in size between the seeds of the various clovers and alfalfa, there is sufficient difference between the kinds and between the largest and smallest seeds of each kind to strongly influence the question of dodder infestation.

The abundance or even presence of dodder in farm seeds is therefore largely dependent on the relative sizes of the two kinds of seed. The combination of the smallest seeded dodders and large-seeded commercial seeds renders successful recleaning possible, while the presence of the larger seeded dodders, especially in small-seeded grades of commercial seeds, gives a practically hopeless mixture.

First-class red clover seed or alfalfa seed should be free from clover dodder. Such alfalfa seed from the West should be free from the small-seeded alfalfa dodder. The large-seeded alfalfa dodder can b only partially removed from average-sized alfalfa seed. Field dodder should be largely removable from the best alfalfa seed, but doubtless can not be even partially removed from any except the large-seeded grade of red clover seed. It is not likely that the seed of any of the dodders can be wholly removed from infested alsike and white clover seed. Pure crimson clover seed, as previously stated, is not under consideration, owing to its early maturity. Such seed should be free from dodder, but if imported yellow trefoil or red clover screenings are used as an adulterant, which form of adulteration appears probable in some instances, dodder may readily be introduced in this way. Clover dodder has been found to be the kind involved in such adulteration. Thorough recleaning in which the trefoil or red clover and the smallest crimson clover seeds are discarded would remove all of this dodder.

Owing to the wide distribution of clover dodder and the small siz of its seeds, it becomes the commonest of the various kinds found in commercial seeds. This is largely the result of the use of low-grad seed and screenings.

The question before the seedsmen regarding freedom of seed from dodder is seen to relate not only to the source of the seed, but very largely to its quality and to the size of individual seeds.

It would seem that attention to the stock with regard to its sour and the kind or kinds of dodder it may contain would tend to impr the quality of seeds offered for sale. Such consideration certai could prevent the mixing of lots some of which are free from do or contain a kind which is readily removable if present. Careful at tention to individual lots of dodder-infested seed could be made yield a smaller bulk of high-grade dodder-free seed worthy of a cor spondingly higher price.

Lastly, the whole matter can be controlled by the dealer whose pu chasing agents are personally familiar with the different kinds of d der in the field and who, guided by this knowledge, will buy dodder-free crops or such as contain only those dodders whose se removable in recleaning.

A KNOWLEDGE OF DODDER SEED OF VALUE TO THE FARME

Since seed from different regions is likely to contain dodder of ferent kinds, the kind has considerable weight as indicating the s of the seed. Indeed, if carefully considered a knowledge of the ki of dodder seeds is very valuable in determining the region wher crop seed was grown. The purchaser is thus enabled to decide whe the seed is of domestic or of foreign origin and in some instances to determine the part of the country from which it comes.

The custom of seed mixing to establish a certain trade grade is often very evident in the character of the dodder the seed contains.

Recognition of the several kinds of dodder seed is essential as preliminary to practical methods of recleaning dodder-infested seed. It is furthermore of interest with regard to the relative importance of the several kinds respecting different host plants and climatic conditions, since we have reason to believe that certain species are less injurious under certain conditions than under others.

Ready recognition of the seeds of the different kinds of dodder is essential to these ends. This is easily accomplished in the main so far as practical requirements are concerned.

HOW THE SEED OF DODDER MAY BE DETECTED.

Detection of the presence in commercial seed of dodder, irrespective of its kind, demands first consideration, because its presence justifies refusal to purchase such seed. A magnifying glass is necessary, as it will enable one to readily distinguish any kind of dodder seed from clover, alfalfa, or flax seed. Dodder seeds are, as a rule, about the same size as red clover seeds, including the smallest and largest seeds. The surface is finely roughened and dull, and the general form varies from nearly spherical to strongly flattened and oval or nearly circular. The color is gray, yellowish, brown, or reddish brown, depending largely on the kind. In contrast, clover and alfalfa seeds are smooth, often with a slight luster. Their triangular, oval, or kidney form aids in distinguishing them from the seeds of dodder.

The use of a sieve with which a considerable quantity of the seed, if in bulk, or all of a sample can be sifted affords the most practical means of detecting the presence of dodder. The sieve should be such that only the smallest or medium-sized crop seeds will pass its mesh. The smaller dodder seeds, such as those of flax dodder, clover dodder, and small-seeded alfalfa dodder, will readily be concentrated to smaller bulk by this means. The large-seeded kinds will be represented by their small seeds. Care should be taken to sift only a small quantity of seed at a time.

As a final resort in case of doubt, examination of the structure of the dodder seed shows it to contain a slender threadlike embryo coiled within the endosperm, which becomes gelatinous when wet. If a few dodder seeds are boiled in water for a time, the embryo emerges from the ruptured seed coat, often becoming separated from it as a slender, coiled object.

DESCRIPTIONS OF DODDER SEEDS.

The seeds of the several kinds of dodder are distinguished by differences in size, form, and surface texture, by the seed scar, and by color. Size and form are modified by the number of seeds developed in the seed vessel. The surface texture varies considerably with the different kinds. The seed scar consists of a more or less distinct circular area surrounding the hilum or immediate point of attachment to the parent plant.

FLAX DODDER.

Individual seeds of flax dodder (*Cuscuta epilinum* Weihe) are much smaller than flax seeds, but a considerable part of this dodder seed consists of two seeds stuck together. This increases the size and weight of the seed and renders it more likely to be retained in the cleaned flax seed. Single seeds are somewhat oval; one face rounded, the other more or less flattened in two planes which slope from a central ridge extending lengthwise of the seed. The scar is a minute whitish point at one end of this ridge, which is flattened. When the seeds are double, they are rounded on one face, practically plane on the other, and angular, oval, or nearly circular in outline. The surface of these seeds is comparatively rough, sometimes even finely scurfy. The color is gray or light brown. Double seeds are about the size of average red clover seeds. (Fig. 2.)

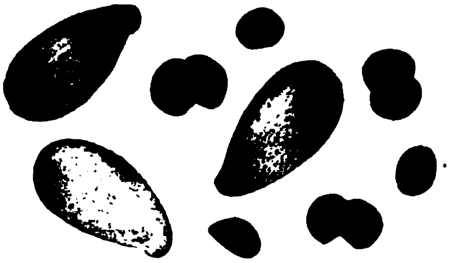

Fig. 2.—Seeds of flax dodder and three seeds of flax, showing relative sizes. Enlarged. (From a drawing by the author.)

The frequent occurrence of double seeds serves to distinguish this kind of dodder from all the others. Again, this dodder is rarely, if ever, found in seed other than flax.

Flax dodder is closely related to the small-seeded alfalfa dodder (*Cuscuta planiflora*) and the seeds of the two kinds are very similar in form. Those of the flax dodder are, however, distinctly larger than the latter.

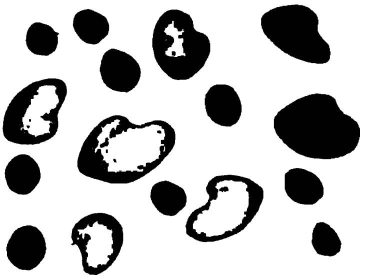

Fig. 3.—Seeds of clover dodder and clover, showing relative sizes. Enlarged. (From a drawing by the author.)

CLOVER DODDER.

The seeds of clover dodder (*Cuscuta epithymum* Murr) are not larger than the smallest red clover seeds, some of them being even smaller. They are nearly spherical when well developed, but some seeds wt.

are not well filled are flattened somewhat, even shriveled. The general color is brown, but some seeds are gray. The darker seeds, at least, appear as finely pitted when seen under a lens. The scar area appears as a minute rounded spot somewhat smoother and sometimes lighter colored than the rest of the surface. (Figs. 3, 4, and 5.) Small particles of clay which are likely to occur in clover seed sometimes become rounded by friction, when they very closely resemble clover dodder seeds. Such particles yield readily to slight pressure with a knife blade, under which they crumble to dust.

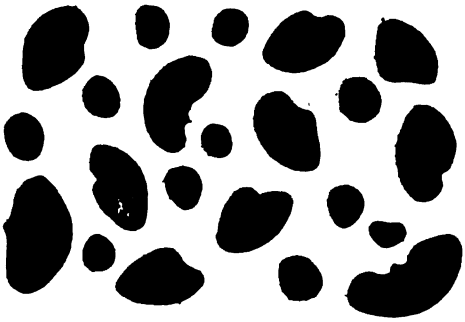

FIG. 4.—Seeds of clover dodder and alfalfa, showing relative sizes. Enlarged. (From a drawing by the author.)

The use of a sieve allowing only the smallest clover or alfalfa seeds to pass renders the detection of clover dodder very easy.

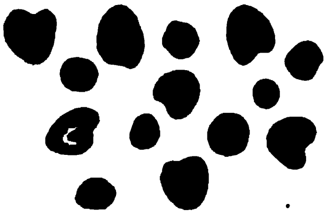

FIG. 5.—Seeds of clover dodder and white clover, showing relative sizes. Enlarged. (From a drawing by the author.)

Clover dodder and the small-seeded alfalfa dodder as impurities of alfalfa seed are likely to be confounded. The clover dodder is distinguished by its more spherical form, pitted surface, and darker or ashy-gray color.

SMALL-SEEDED ALFALFA DODDER.

Seeds of this alfalfa dodder (*Cuscuta planiflora* Ten.) are minute, much smaller than alfalfa seeds. They are therefore readily detected by using a sieve only sufficiently fine to hold practically all of the alfalfa seed. The seeds are oval or oval-oblong, rounded on one face, the other flattened in two planes which meet at a central ridge extending lengthwise of the seed. At one end of the ridge this face is beveled. The resulting area contains the hilum as a minute whitish point. The surface is comparatively rough as viewed under a lens. The color is variable. Some seeds are greenish; others are strongly tinged with purple. As a rule the seeds have a yellowish straw color. (Fig. 6.)

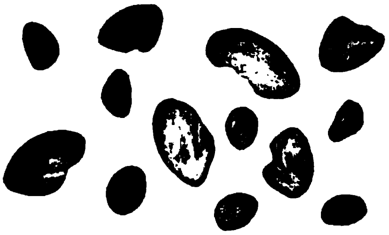

FIG. 6.—Small-seeded alfalfa dodder and alfalfa seeds, showing relative sizes. Enlarged. (From a drawing by the author.)

The oval and angular form and the yellowish or greenish color of these seeds render them readily distinguishable from those of clover dodder.

FIELD DODDER.

The seeds of field dodder (*Cuscuta arvensis* Beyrich) are larger than those of any of the preceding kinds, except the double seeds of flax dodder. Their size varies as a rule between that of the smaller and that of average red clover seeds. These seeds are oval or nearly circular in outline, rounded on one face, and variously flattened and angled or deeply grooved on the other. The scar as a rounded area containing a short whitish hilum appears at one end of the flattened face. The color is lemon-yellow, gray, or light brown. (Figs. 7 and 8.)

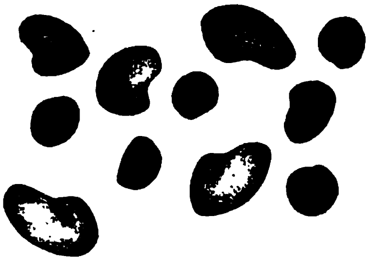

FIG. 7.—Seeds of field dodder and red clover, showing relative sizes. Enlarged. (From a drawing by the author.)

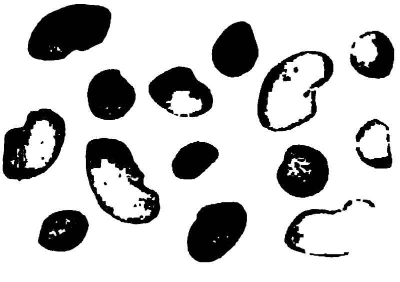

FIG. 8.—Seeds of field dodder and alfalfa, showing relative sizes. Enlarged. (From a drawing by the author.)

LARGE-SEEDED ALFALFA DODDER.

Seeds of this alfalfa dodder (*Cuscuta indecora* Choisy) are similar in a general way to those of field dodder. They appear to show greater variation in size than the other kinds. There is also considerable difference in form. Seeds of a certain size and form therefore are very similar to those of field dodder, but are scarcely to be confounded with seeds of the first three kinds described. The largest seeds are most characteristic of this species. They are nearly circular in outline, but are usually somewhat broader than long—that is, the scar appears to be at one side of the seed, whereas it is really at the basal end. Such seeds are convex on one face and plane or broadly grooved on the other bearing the scar, which is comparative

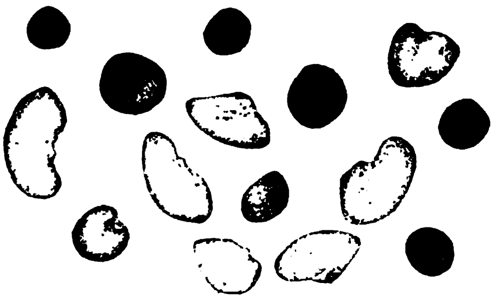

FIG. 9.—Seeds of large-seeded alfalfa dodder and alfalfa, showing relative sizes. Enlarged. (From a drawing by the author.)

indistinct. The color is gray or brown, sometimes very dark. The surface is often very rough or scurfy. These seeds are to be looked for in alfalfa seed from the western United States. (Fig. 9.)

CHILEAN DODDER.

Seed found in South American red clover and alfalfa seed and determined to be of the species and variety *Cuscuta racemosa chileana* Engelm. is larger and usually more plump than seed of field dodder (*Cuscuta arvensis*). It is reddish brown and the surface is often strongly roughened. The most evident point of difference between this and field dodder lies in the scar. The hilum appears as a point-like depression in the center of the circular scar area. In field dodder a short whitish line not depressed represents this part of the scar.

The seeds of this dodder appear to occur at the present time only in South American seed. Along with this seed are found seeds of a different kind, however, which are similar to and perhaps identical with field dodder.

BUYING SEED.

Every purchaser of clover or alfalfa seed in the open market is likely to receive dodder-infested seed unless it has been found by thorough test to be free from dodder. As previously shown, this liability is due to the several kinds of dodder involved, the extensive field of seed production, the custom among dealers of mixing different lots, and the practice of using low-grade imported seed in adulteration. The average farmer has himself to blame for some of these adulterants, which are often employed by dealers to meet the farmer's demand for cheap seed. With respect to dodder, as well as other impurities, cheap seed is always to be looked upon with suspicion and as a rule is to be avoided.

Often seed of local production from fields known to be free from dodder can be obtained. If well cleaned it is preferable to the average seed in the market. Seed from dealers should be bought by sample, accompanied by a time limit within which the dealer agrees to furnish the same seed in bulk. Such samples should be tested for dodder. If tested at a State agricultural experiment station or at the United States Department of Agriculture some delay is sure to result. The test is so simple and so quickly made that the farmer should himself make it, thus permitting an immediate order for the seed if desired.

The responsibility of any test ends with the particular lot sent for test, and the presence of a few dodder seeds in the bulk lot of any seed represented by a small sample is always possible. The ill effects likely to result will be evident in the young stand of the crop.

With regard to the importance of using only dodder-free seed, it may be said that badly infested fields are practically ruined by certain kinds of dodder and that the loss of the crop is propostional to the extent of the infestation. The seed crop is reduced in quantity and quality. The reduced quality of the seed crop is not represented wholly by a dodder-infested crop, but also by the fact that the dodder so reduces the clover plants' food supply that the crop is likely to be of lighter weight than it otherwise would be. Again, dodder seed production is likely to so contaminate the land with seeds that a return to clover or alfalfa may be accompanied by dodder infestation, even though pure seed be used.

The period of seeding probably has considerable bearing on the results from using dodder-infested seed. Spring seeding is most favorable for growth of the dodder. It is an unsettled question whether dodder plants in the field ever live over winter. It appears that very few, if any, survive. In consequence of this fact, summer or early fall seeding, too late to enable the dodder to produce seed, tends to free the crop of the following season from dodder. Considerable damage from the dodder might occur to the seeding, however, during the first season. Furthermore, some dodder seeds might not germinate till the following spring.

CLEANING SEED.

Under certain conditions it may become necessary to remove the dodder seeds from an infested lot of seed in order to prevent its loss. While the average farmer might hesitate to discard a purchase of seed because of its dodder seeds, badly infested seed would be far more profitably discarded than sown without thorough recleaning.

The successful removal of dodder depends on the kinds of seeds involved and their consequent relation respecting size. It is doubtful if alsike and white clovers can be cleaned of dodder, although the amount of clover dodder can be reduced somewhat by the use of proper sieves, which, however, necessitate the loss of considerable clover seed.

Red clover and alfalfa seeds can be cleaned of clover dodder and small-seeded alfalfa dodder by the use of a sieve having 20 meshes to the linear inch and made of wire ranging from No. 30 to No. 34 of Washburn and Moen gauge. This statement is based on experiments with sieves of this mesh made of Nos. 30, 32, and 34 wire. Samples of the above kinds of dodder, as found in commercial seeds and as taken from fruiting plants, were employed in the experiments. Especial attention was given in the trials to the largest of the seeds of these kinds. It was found that either of these sieves will admit all the seeds of these species with proper care in the sifting. If a sieve of the mesh made of wire coarser than No. 30 of Washburn and Moen gauge is used, the largest dodder seeds of the above kinds will be retained by it; while, if the mesh is coarser than provided by No. 34 wire, there will be an undue loss of crop seed, especially in the case of small-seeded red clover. The loss of alfalfa seed is comparatively small when using any of the sieves recommended. The same is true of the better, large-seeded grades of red clover seed. In the case of the small-seeded grades of red clover the loss of seed when a sieve of No. 34 wire is used may amount to the greater part of the bulk. The sieves made of the coarser wire are better adapted for such seed. Small-seeded grades are usually low-grade screenings which carry small weed seeds, many of which are removed by the sieve.

The farmer may find it difficult to secure the proper sieve. Manufacturers do not carry all of the sizes in stock. The writer has found the 20-mesh No. 30 wire in the stock of one firm and the No. 32 wire in that of another. The other sizes may be carried by other dealers, but from what has been learned these sizes have to be made to special order, and an order for a considerable quantity is demanded.

The efficient use of any of these sieves requires that much care be taken to do thorough work. Only a small quantity of seed should be sifted at a time. The sifting should be continued until all of the seed has been brought in contact with the wire. It is believed that the most effective work will result from using first a No. 34 wire sieve and then passing the siftings thus obtained over a sieve of No. 30 wire.

With respect to the other kinds of dodder discussed in this bulletin and found in clover and alfalfa seeds it may be said that none of the sieves mentioned will remove all the seed, even with repeated sifting. Much of the dodder seed will be removed, especially if a sieve having No. 34 wire is used. Thus far no means of wholly removing these large-seeded kinds is known.

Deep seeding of the crop appears to be the most promising course for the farmer to follow in using seed known to contain seeds of the large-seeded dodders. By this means many of the dodder seeds will be buried too deep to permit their plants reaching the surface. Sifting the seed, by which as much as possible of the dodder is removed, is therefore most advisable.

Flax dodder can be removed from flax with very little loss by the use of a sieve of 14 meshes to the linear inch and made of No 29 wire, W. & M. gauge.

It often happens that seed is retained by unopened dodder capsules, which permit it to remain with the seed held by the sieve.

DETECTING THE DODDER PLANTS IN THE FIELD.

It has been shown that notwithstanding every precaution against the introduction of dodder, seeds may find their way to the field in the seed used. The ultimate control of the plants may depend upon early efforts to discover and destroy them. This is particularly true if the plants appear in few places in the field.

The proper time to destroy the plants is before rapid branching enables them to reach many host plants. Then every firm hold of the dodder suckers becomes a point of independent growth, and the difficulty of reaching all of them is greatly increased. New seedings, therefore, should be carefully examined for this pest.

Under favorable conditions the dodder seeds germinate but little slower than seeds of clover and alfalfa. The young plants therefore appear at about the same time as the clover. Their discovery in the seeding at first is practically impossible. By the time the crop is 6 or 8 inches high the dodder will have branched sufficiently, as a rule, to render its presence noticeable for a short distance. This permits removal of the plants with the least loss to the stand and with the most likelihood of success.

Different kinds of dodder exhibit in the field individual habits well worthy of consideration in detecting their presence, such as low-growing or high-growing tendencies and their manner of spreading from plant to plant.

Field dodder grows to the top of the host plants, throws out its branches, and rapidly extends from plant to plant, often forming a dense yellow carpet of tangled branches covering and bearing down the crop. (Fig. 10.) Small-seeded alfalfa dodder, on the other hand, confines its growth exclusively to the lower part of the host plant, rarely exceeding a foot from the ground. It spreads slowly from plant to plant, confining itself chiefly to the several branches of the individual alfalfa plant. While a patch of field dodder can be seen a long distance, the other, when the stand is at all thick, can be observed for but a few feet.

The habit of clover dodder differs from that of each of the kinds previously described. Its flowering stems usually climb the host stem for a foot or more. The vegetative stems, by means of which the plant spreads to new host plants, form a dense mat, or carpet, close to the ground, winding in and out among the host stems, often completely surrounding them and hiding the ground. In this way the spreading of the plant is rapid and very effective. The early growth of this plant is not readily detected at a distance.

The effect on the crop differs with these different habits of growth. Field dodder destroys its host plants in irregular patches, probably in many instances as much by bearing down and smothering the crop as by the withdrawal of plant food. All of the crop plants within an infested area are likely to be attacked. Small-seeded alfalfa dodder, confining its attacks chiefly to individual resistant and naturally long-lived plants, eventually causes a general thinning of the stand through the death of scattered individual plants. Healthy, infested, and nearly dead alfalfa plants thus often occur in close proximity.

Clover dodder attacks every clover plant and to a greater or less extent other plants within the infested area. It destroys rapidly, and its progress from the original point of attack is so uniform that disnctly circular areas bared of living clover or alfalfa result. These ircular spots of dead plants are very characteristic marks of the estruction caused by this species. A narrow band of living dodder ems will be found bordering the circle of destroyed plants

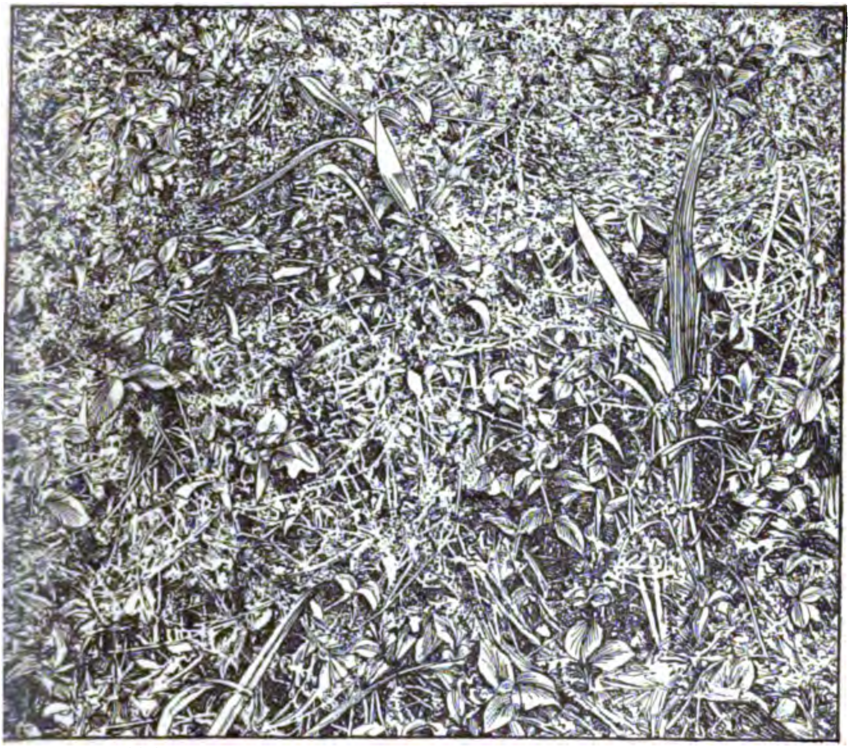

FIG. 10.—Field dodder covering red clover and grasses. From a photograph of an infested field.

Flax dodder bears down the flax plants and is therefore sometimes illed "pull-down." It also draws the tops of the plants together. oth large-seeded alfalfa dodder and Chilean dodder ascend to the top the host plant. The former produces dense flower and fruiting usters; the latter appears to have a more open habit and scattered wer system.

The form and appearance of the flower clusters differ with the different kinds of dodder. Clover dodder flowers are in small compact clusters of several flowers each. The clusters as well as the stems are often tinged with red. Small-seeded alfalfa dodder flowers are in similar clusters which are not colored. Field dodder flowers are in looser clusters scattered among the branches or crowded in bunches.

DESTROYING THE PLANTS.

When failure to prevent the introduction of dodder seed occurs, the destruction of the plants becomes the final resort. The questions of success and the extent of the necessary damage to the crop at once arise. Their answers rest with the kind of crop infested, the stage of development of the dodder, the extent of the attack, and the methods of eradication employed.

The problem of dodder control is strongly influenced by the character of the crop infested. Red clover remains but two, or at most but three, years without reseeding. If the dodder is prevented from seeding it should be eradicated within this time, or at least should not interfere with the course of crop rotation. Alfalfa should remain indefinitely, and if dodder reseeds itself its control becomes much more difficult or impossible. This is the prevailing condition in the West. The fact that the small-seeded alfalfa dodder of the West has not become established in the East is of special interest in this connection. Clover dodder appears likely to prove most troublesome in alfalfa culture in the East.

If the dodder occurs only in patches in the field it usually can be controlled by hand methods. If it covers the greater part or all the field, plowing under the stand will probably be found necessary. It then becomes important to know how far the crop can be utilized without reseeding the land to dodder.

It is first important to gain control before the plants have spread far from the point of attack; secondly, and of greater importance, they should be subdued before they produce seed. Success therefore depends very largely on early discovery of the plants, followed immediate work in subduing them. Thoroughness involves the destruction of every living piece of dodder stem lying within its own length of a host plant.

Cutting and burning infested plants and spraying them with copper sulphate or iron sulphate are methods which have been employed. Spraying has not proved successful as a rule, owing to the impossibility of thoroughly wetting every part of the dodder stems under field conditions. The plants have appeared to be destroyed, but sufficient number remained to continue growth after receiving temporary check. Burning is successful when thoroughly done.

This may or may not destroy the crop roots. The burning may take place on the infested spot or the cut plants may be removed to be burned elsewhere. Burning on the spot is an advantage, on account of its destroying dodder missed in cutting and seeds which have fallen. Burning endangers the life of the roots of the crop, however. The removal of infested plants to another place requires great care to prevent any of the pieces of dodder falling on the crop and establishing new centers of growth, and the use of sacks or some similar means of removal is advised.

In cutting infested plants care should be taken to carry the work far enough on the borders to include all of the dodder. Cutting close to the ground is equally important. The recognition of the different habits of different kinds of dodder may be helpful in this connection. Small-seeded alfalfa dodder is confined largely to individual plants, and if all these can be located and destroyed there may be little danger of further damage. This plant grows very low, however, and there is little hope of saving the crown of individual alfalfa plants. Field dodder spreads in every direction, but irregularly, and all through the crop plants from their tops to the ground. It may be difficult to determine the borders of an infested patch. All of the infested area should be cleared, but often the stand may be saved. In the case of clover dodder, particularly in an advanced stage, all the plants of a circular area are killed, while the active growth of the dodder is confined to a band of infested plants immediately surrounding this area. Cutting and burning this ring of plants where it falls will probably be found most effective, because the carpet of dodder stems is so dense and so low that its complete removal is practically impossible. Careful examination of the ground may show individual dodder stems creeping a foot or two farther into the crop than otherwise would be evident. Success depends on destroying such stems. Patches of ground cleared of clover by this dodder may contain its seed. Such areas should be burned over to kill this seed before resowing to clover.

The small-seeded alfalfa dodder as a pest of alfalfa in the West is a problem in itself. It has become so widely prevalent that its permanent eradication locally becomes practically impossible in many cases. Not only is much of the seed used in the West likely to contain its seed, but it is readily carried from farm to farm in irrigating water. Bunches of dodder-infested hay fall in various places in the field and along the roadsides, and in this way scatter seeds. Thus conditions are conducive to keeping the fields infested.

Methods of reasonable control of this dodder appear to be more promising in the West than attempts to eradicate it. Observations have shown that low-lying, well-irrigated lands are not infested to the same extent as the higher and drier lands. It is, therefore, possible that confining alfalfa culture to lands capable of abundant irrigation and destroying the stand of alfalfa on the drier land when infested with dodder will tend to reduce the loss from the pest, even though it may remain.

Plowing should precede the seeding of the dodder. In this way all danger of future occurrence of the pest is averted if all infested plants are covered. If the plowing is delayed until after the dodder develops its seed the crop can be burned over, producing a hot fire before the surface soil is disturbed. This should destroy the greater part of the seeds lying exposed on the surface of the soil and in unopened seed vessels. In lieu of either plowing or burning over dodder-sown ground, shallow cultivation, followed by some crop requiring frequent surface tillage, will tend to keep the seeds near the surface and perhaps lead to the destruction of the greater part of them.

It is believed that as a rule dodder plants will not injure such a cultivated crop. This is doubtless true of clover dodder and small-seeded alfalfa dodder. Certain crops might, however, be injured by field dodder or large-seeded alfalfa dodder. The injury to beets in Utah caused by field dodder, previously noted, and the observations of the writer upon the growth and effect of large-seeded alfalfa dodder on various coarse plants justify the recognition of the possibility of damage from these kinds.

It is important in such surface cultivation that the dodder seeds do not become covered too deep, as it is known that they are capable of remaining alive for several years when buried. In one authentic case at least 16 per cent of a quantity of buried seed germinated at the end of three years.

An infested stand of clover or alfalfa may safely be allowed to produce a crop of hay or be used for pasturage or for soiling provided the crop is removed before the dodder produces seed. The removal of a bulky crop aids in the complete covering of the stubble, which is important. Plowing should follow immediately after the removal of the crop; otherwise mature dodder seeds will be buried and possibly prove troublesome on again being brought to the surface.

Dodder is not poisonous to stock. Hay carrying dense bunches of it is usually pushed aside by stock. The Utah farmer previously referred to as having obtained 60 bushels of dodder seed by recleaning his seed crop stated that he fed this seed to stock without ill effect.

SUMMARY.

(1) Dodder is a parasitic plant dependent on a host plant for its food. It reproduces by means of seeds and from pieces of stems permitted to come in favorable contact with a suitable host plant.

(2) There are several kinds of dodder especially destructive to flax and to leguminous crops.

(3) The dodders exhibit pronounced preferences for certain kinds of host plants, with the result that a crop is not equally subject to injury from different kinds of dodder.

(4) Climatic and weather conditions strongly influence the growth and productiveness of the dodders. Thus, small-seeded alfalfa dodder, so common in the West, appears to be unknown in the Eastern States, and clover dodder produces so little seed in this country that its seed rarely, if ever, is found in American-grown red clover seed or alfalfa seed.

(5) Dodder seeds are a very common impurity of clover, alfalfa, and flax seed in the trade. Certain kinds are more commonly found in domestic than in foreign seed, while the contrary is true of other kinds. Low-grade seed imported from Europe generally contains dodder.

(6) Dodder seeds can readily be distinguished from crop seeds by a seedsman or farmer using a magnifying glass.

(7) Certain kinds of dodder seeds can be thoroughly cleaned from the best grade of farm seed. Other kinds can not be wholly separated from the seed which carries them.

(8) Some dodder seed is likely to escape removal in recleaning, and the young seeding should therefore be examined for dodder plants.

(9) The dodder plants should be discovered early and destroyed by removal or burning.

(10) Dodder plants should not be allowed to seed, thereby contaminating the land.

(11) Hand methods may subdue the dodder plants if they are not too abundant; otherwise plowing under before they go to seed or burning the stand if seeds have already ripened will be necessary.

(12) The early crop of clover or alfalfa preceding the ripening of the dodder seeds can safely be used as pasturage, for soiling, or in hay making. The infested stubble should be plowed under immediately.

(13) The most generally effective means of preventing the introduction of dodder is to use seed free from dodder seeds. The purchasing farmer can easily make a reasonably satisfactory test for dodder seed.

(14) Where irrigation is practiced dodder seed may be carried from place to place in the water used.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 307.

ROSELLE: ITS CULTURE AND USES.

BY

P. J. WESTER,
Special Agent, Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 4, 1907.

Sir: I have the honor to transmit herewith the manuscript of a paper entitled "Roselle: Its Culture and Uses," by P. J. Wester. Special Agent at our Subtropical Laboratory and Garden, Miami, Fla. and to recommend that it be published as a Farmers' Bulletin.

The roselle plant is adapted for culture in the tropical and subtropical regions of the United States, and should be especially valuable in southern California, Florida, the tropical islands of the United States and in the Canal Zone. It is used in the South very much as th cranberry is used in the North, and is especially valuable for th making of jellies.

In the preparation of this bulletin the writer has received man valuable suggestions and considerable aid from Dr. Ernst A. Bess Pathologist in Charge of the Subtropical Laboratory and Gard Miami, Fla. Dr. L. O. Howard, Chief of the Bureau of Entomolo identified the soft scale and yellow aphis, and Dr. H. W. Wiley, Ch of the Bureau of Chemistry, made the analyses of the roselle and th cranberry.

Respectfully,
B. T. Galloway,
Chief of Bure

Hon. James Wilson,
Secretary of Agriculture.

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ROSELLE: ITS CULTURE AND USES.

INTRODUCTION.

Fruits and economic plants indigenous to the Tropics are now as never before attracting the attention of the people of the United States. Some, such as the avocado and the guava, are natives of the Western Hemisphere; others, like the roselle, are introductions from the Old World.

A strictly tropical plant, the roselle is very sensitive to frosts. This, together with its peculiar habit of blooming late in October regardless of the time when the seed is planted, has restricted the cultivation of the roselle to tropical and subtropical regions. Its distribution, for this reason, has not been so general nor has the plant become so widely known as introduced plants indigenous to the Temperate Zone. It is, however, only rational to assume that this objectionable feature could be overcome were persistent efforts made with that end in view and that the roselle, like so many other cultivated plants which have yielded to changed climatic conditions, would adapt itself to the shorter summers of a higher latitude.

Introduced several years ago into California and Florida, the roselle deserves a wider cultivation than it now enjoys and should prove a valuable acquisition to the tropical islands of the United States and to the Canal Zone. The cultivation of the roselle is so simple and its requirements so few that in the Tropics and Subtropics it should be an indispensable plant in the garden of every family. This fact, in view of its peculiar adaptability for jelly making, should cause the roselle to become a plant of considerable importance in the United States at no distant date. The roselle is probably the only plant in cultivation in which the part utilized for food[a] is the calyx. Of rather low nutritive value, the thickened calyx possesses excellent qualities for the manufacture of jelly and allied products. Preparations made from it closely resemble in color and flavor those made from the cranberry. It is rather singular that its season of maturity also coincides with that of the cranberry.

In Queensland, where the culture of the roselle has in recent years assumed considerable proportions, the fruit is utilized largely in the manufacture of jam. In the United States its principal use would probably be as a substitute for cranberries in the household and in the manufacture of jelly.

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[a] For analyses showing the food value of the calyx and pod of the roselle, see Farmers' ulletin 293, page 14.

HISTORY AND GEOGRAPHICAL DISTRIBUTION OF THE ROSELLE

The almost total absence of literature relative to the roselle until the last two decades and the lack of cultural varieties would seem to indicate that the culture of this plant is of comparatively recent origin. De Candolle, in his "Origin of Cultivated Plants," 1885, does not mention it.

The writer has examined many of the older works on Indian agriculture without finding more than one referring to the roselle. This work[a] is devoted to fiber-producing plants, which shows that roselle was early cultivated for its fiber. The author says, speaking of roselle, okra, and *Hibiscus abelmoschus:* "The dietical use of these species has been mentioned in order to show that if cultivated on account of their fiber they would also be useful for other purposes and it would seem from this quotation that the various uses of the roselle were not generally known at that time. For more than thirty-five years subsequent writers on Indian agriculture maintain absolu silence on the subject, and Duthie[b] mentions the plant only incidentally. Woodrow[c] speaks of its utility for jelly making. I India the plant has been grown chiefly for its fiber. It has apparently not attained much importance for culinary purposes.

The writer has been unable to obtain any data relative to the introduction of the roselle into the British colonies in Australia where its cultivation evidently is more extensive than anywhere else in the world, as, according to Semler,[d] two large preserving factories utilizing the roselle were in operation in Queensland in 1892. Shinn refers to roselle jam as being shipped to Europe in large quantities.

The Queensland Agricultural Journal, volume 6, page 371, published in 1900, contains the longest treatise on the roselle that come to the attention of the writer. Its brevity, it being less t five pages in length and containing no references to any previ literature, presupposes the recent development of the industry th In Queensland the calyces are mainly utilized in the manufactur jam, but are also, according to the article cited, well adapted pickles, while the writer also calls attention to the fact that roselle can be propagated from cuttings and that such plants fruit when earlier and more vigorous seedlings bear little or none. seed is sown in October in Queensland.

The roselle is hardly mentioned in the horticultural literatur the West Indies, indicating that it is an object of indifference th It was probably introduced from India before 1855, as Royle work published that year says that it is there called "red sorrel."

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[a] Royle, J. F. Fibrous Plants of India, 1855, p. 260.

[b] Duthie, J. F. Field and Garden Crops of Northwestern Provinces and Oudh

[c] Woodrow, M. Gardening in India, 1899, p. 183.

[d] Semler, H. Die Tropische Agricultur, 1892, p. 391.

[e] Report of the California Agricultural Experiment Station, 1896–97, p. 3

In Hawaii the roselle, although introduced long ago, has not received much attention.

Eleven or twelve years ago a Mr. Neustadt, of San Francisco, imported seed from Queensland, and the plant was tested and seed subsequently distributed in California by the agricultural experiment station of that State. The plant received much favorable comment there from those who tested it at that time.[a] Later literature is silent on the subject.

The name in Florida, "Jamaica sorrel," is evidently an indication that the plant was introduced from Jamaica—at what date the writer has been unable to ascertain—but it was probably not extensively grown in Florida before 1887, as P. W. Reasoner[b] does not refer to it. Harcourt[c] does not speak of it.

In Florida, as in California, those who have tried the roselle have nothing but praise for the plant, and considerable interest in it is manifest, but its culture on a large scale has not yet, to the knowledge of the writer, been undertaken by anyone.

The assumption by Royle[d] that the name roselle is a corruption of the French word "oseille" (the equivalent of the English "sorrel") seems very probable. In the evolutionary stages the name has at different times been spelled "rouselle," "rozelle," and "rosella."

BOTANICAL CHARACTERS AND RELATIONSHIPS.

Roselle (*Hibiscus sabdariffa* L.), or Jamaica sorrel, as it is sometimes called, is an annual from the Tropics of the Old World belonging to the large family Malvaceæ. Itself furnishing the roselle fiber of commerce, it is closely related to several genera containing fiber-producing plants: Sida, Malva, Althea, and Lavatera. Its most important relative is cotton (*Gossypium* sp.). Of vegetables, okra (*Hibiscus esculentus* L.) is related to the roselle. Among related ornamental plants may be mentioned species of Abutilon, Hibiscus, Althea, and Malva.

The habit of the roselle (fig. 1) is similar to that of the cotton plant; the stem is reddish, branching profusely. As usually planted—that is, in February and March—the roselle attains a height of from 5 to 7 feet. The leaves on the young plants are entire; as the plant increases in size the leaves change to palmately five parted; later, the leaves in whose axils the flowers are borne are three parted. The arge, almost sessile yellow flowers, each with a red eye, are usually borne singly in the axils of the leaves (fig. 2). They fade before the day is past and the subsequent enlargement of the calyces is then very rapid. In less than three weeks they attain their full size and are ready for picking (figs. 3, 4, and 5). If the "fruit," if we may so call it, is not now picked and the seed is allowed to mature, the plant dies early in January. There are in the axils of the leaves several latent flower buds, and when the calyces are picked as soon as they are full grown these buds develop and the productivity of the p- is greatly increased.

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[a] Report of the California Agricultural Experiment Station, 1897–98, p. 236.

[b] Bul. 1, Division of Pomology, U. S. Dept. of Agriculture, 1887.

[c] Harcourt, H. Florida Fruits, 1886.

[d] Royle, J. F. Fibrous Plants of India, 1855, p. 260.

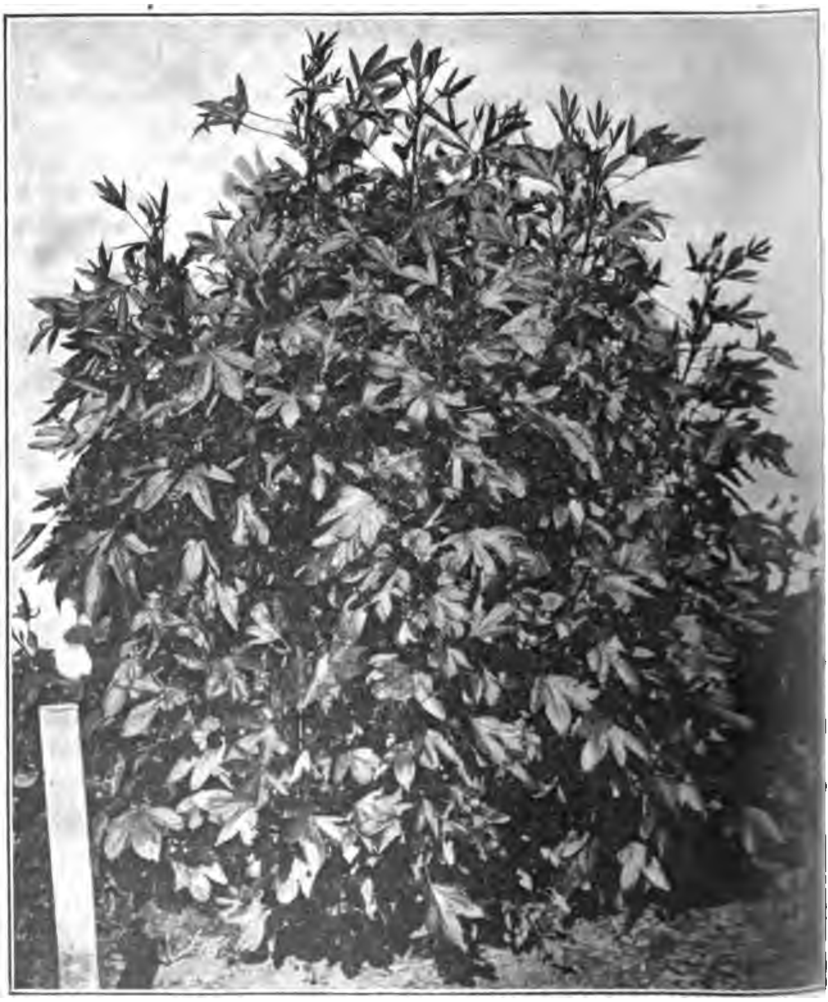

FIG. 1.—Roselle plant.

VARIETIES.

The roselle being a plant of recent cultivation and one that onl a slight extent has been exploited for commercial profit except fiber plant, it having been grown mostly as a curiosity in the gar of interested individuals without any thought of improving plant, it is only natural that no cultural varieties have developed.[a] Without any thought of improving the roselle, the writer during the summer of 1904 obtained a few plants in Cocoanut Grove, Fla., from Mr. W. A. H. Hobbs and planted them in the Subtropical Garden, Miami, Fla., in order to have the plant under observation.

As the plants bloomed and fruited the marked variation in the fruits on the different plants suggested that there was an excellent opportunity to breed a new and distinct strain of the roselle, and at the suggestion of Prof. P. H. Rolfs, at that time Pathologist in charge of the Subtropical Laboratory and Garden, seed was saved from the best plants. With this seed for stock the writer began systematized breeding the next year. A number of the plants fruiting in the autumn of 1906 had calyces of such large size and exhibited such distinct characters that they were thought worthy of naming as a variety, and the name "Victor" has therefore been given to this sort.

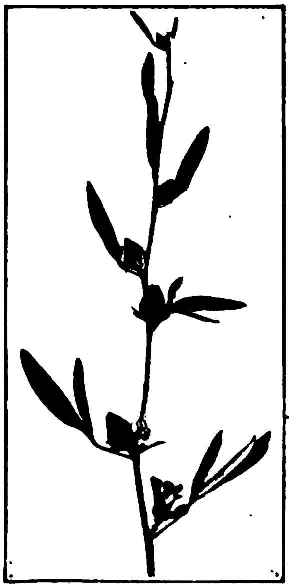

FIG. 2.—Branch of the roselle plant, showing blossoms.

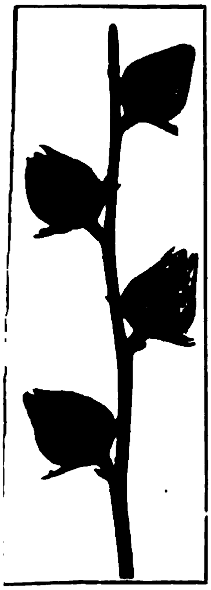

FIG. 3.—Mature calyces of the ordinary roselle, somewhat affected by mildew. (Three-tenths natural size.)

The improvement of these plants over the common kind is best illustrated in figure 5. When it is remembered that these are from plants in the second generation, the improvement is remarkable. As it was thought that these plants might be a special strain, inquiries were made to find out whether the original plants had any previous history, but this inquiry only served to confirm the fact that they were of the ordinary variety grown in Florida. Mr. William A. Taylor, of the Bureau of Plant Industry, suggested to the writer that this capacity for improvement might be due to the fact that the roselle has previously been principally grown for fiber, which doubtless is correct. Another attempt to breed the roselle was made by Dr. H. J. Webber in the nineties at Eustis, Fla., where the Subtropical Laboratory was then located. This work was, unfortunately, terminated by the severe freeze of 1895.

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[a] Since this article was written O. W. Barrett, of the Bureau of Plant Industry, has informed the writer that he has heard of a variety with straw-colored calyces. This report, however, has not been verified.

The plants of the Victor variety are inclined to be a trifle more dwarf than the common kind, but the foliage is similar. The measurements of the calyx of the common variety are, length 33 mm., diameter 22 mm.; in the improved type the measurements are 49 mm. and 28 mm., respectively. The increase in size is thus seen to be rather more in length than in diameter. Calyces of the improved type have in some instances been 60 mm. long and 38 mm. in diameter. (See the two detached calyces in fig. 5.) The improved type is also distinct in being more strongly ribbed longitudinally and in having the calyx not so closely appressed to the seed pod as in the common variety. It is frequently inclined to be convolute at the apex.

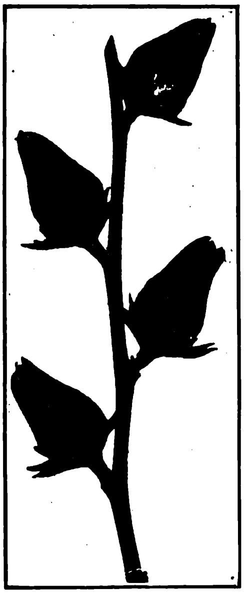

Fig. 4.—Mature calyces of the Victor roselle, somewhat affected by mildew. (Three-tenths natural size.)

CULTIVATION AND FERTILIZATION.

The roselle will thrive on any soil that is moderately rich or that is supplied with the necessary plant food in the form of commercial fertilizer. Stable manure should be used sparingly only and should be supplemented by phosphates and fertilizers containing potash, as an excess of ammonia in the soil tends to the development of large plants at the expense of their productiveness. This is particularly true on low-lying land where moisture is abundant, and the high pine lands in Florida are for this reason preferable to the muck and prairie lands. Land that is subjected to inundations and soil insufficiently drained should be avoided. The plant has been found well adapted to the clayey soil of California. Henricksen[a] says that a sandy loam is preferable to other soils.

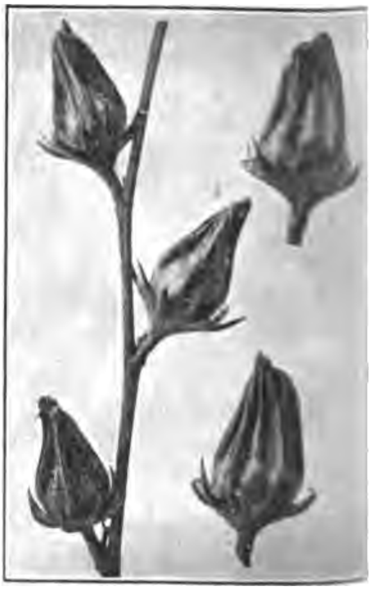

Fig. 5.—Mature calyces of the Victor roselle. (Two-fifths natural size.)

The roots of the roselle descend to greater depths than those many other crops, and the land should be plowed deep and, when soil is clayey, well pulverized. This plant is very much subject to root-knot nematodes (*Heterodera radicicola*) and should not be planted on land infested with this pest, as that would only result in almost absolute failure.

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[a] Bul. 171, Office of Experiment Stations, p. 38.

The roselle always comes to the market at the same time of the year, and, as no literature on the subject that had come to the attention of the writer mentioned any attempt to grow it successively, several sowings were made in 1906 at the Subtropical Laboratory at different times of the year, to note the influence on the habits of growth, the season of maturity, and, possibly, the size of the calyx. These plantings were made as follows: No 559, April 1; No. 560, May 1; No. 561, June 1; No. 562, June 23.

Besides these, seeds from large selected pods were sown June 26 (No. 542). Plant No. 542 came into bloom October 26, a few days in advance of Nos. 560, 561, and 562. A few days later bloom was noted on No. 559. Notes made in 1905 show that plants from seed sown on June 10 bloomed October 25. The plants from the earlier sowings naturally developed into large plants, with greater bearing capacity. This advantage was offset, however, by the fruits being to a marked degree smaller than those from later sowings. A comparison of the different plants in this experiment indicates that to combine high yield with the production of large pods the seed should be planted about May 15 in south Florida.

Make the seed bed in a place sheltered from high winds and work in thoroughly a moderate quantity of stable manure or commercial fertilizer. Sow the seed thinly in drills 6 inches apart, covering the seed from ¼ to ½ inch; then firm the soil and, if dry, water thoroughly. The seed will germinate in a few days. If the weather is dry, the young plants should be watered as occasion requires. When the plants are 3½ to 4 inches high they are ready for transplanting to the field.

The plants should be set out in rows 6 to 10 feet apart and 4 to 8 feet apart in the row, according to the fertility of the land and the supply of moisture. The seedlings are easily transplanted if proper precautions are taken. The work should preferably be performed on a cloudy day or late in the afternoon. Where a few plants are desired for home use only it will be found advantageous to sow a few eeds where the plants are to remain permanently and when the lants are well developed to thin out to one plant to a hill.

Experiments with different fertilizers have been started at the Subropical Laboratory, but have not been carried on for a sufficiently ong time to indicate the best form in which the fertilizer should be pplied. Meantime a formula of nitrogen, 4 per cent; potash, 7 per ent, and phosphoric acid, 6 per cent, has given good results. One-hird of the actual ammonia is derived from nitrate of soda and the other two-thirds from dried blood. The sources of potash and phosphoric acid are muriate of potash and acid phosphate, respectively.

The fertilizer should be applied at the rate of from 1,000 to 2,0 pounds to the acre, according to the fertility of the land. On lands rich in ammonia the nitrogenous elements should be greatly reduced. It should be understood that this applies to Florida soils and conditions. The amount, and possibly the formula, would probably have to be modified in other sections. In the sandy and leachy soils of Florida it will be found advantageous to make several small applications instead of applying the total quantity at the time of planting No cultivation is necessary, except to stir in the fertilizer and to kee down the weeds while the plants are small. When the ground is well shaded by the plants cultivation may be discontinued.

YIELD.

During 1906 experiments were well under way to ascertain the tota yield of the roselle plant, but a hurricane in October inflicted so mu damage on the plants in the experimental area that accurate da were unobtainable. Henricksen[a] quotes the yield as four pounds of fruit to each plant, averaging two pounds of calyces, the usef part, and adds, "Plants observed at Pueblo Viejo in sandy loam we estimated to yield double that amount."

HARVESTING AND MARKETING THE CALYCES.

In less than three weeks from the time of flowering, the calyces ready for picking. In south Florida the first fruit is gathered ab the middle of November.

It has been already pointed out how the yield may be lar increased by picking—going over the field every few days to pick full-grown calyces, which will force the plant to send out new flow buds. By these repeated pickings the plants are forced to fruit tinuously until late in February, whereas otherwise they would ce to bear in December. Moreover, the calyces are more brittle a more easily broken from the plants while young and tender, and in manufacture of jelly make a lighter red and a more transpar product than those from the more mature fruit. On poor lan would be of advantage to make a small application of fertilizer to plants in December.

The fruit is seen at present in local markets only and is sold the quart. Its excellent qualities for making a sauce so cl imitating in flavor the cranberry as to deceive the very elect are well known by the public or it would be a formidable rival in South to that fruit, on which transportation charges are neces high owing to the great distance it must be transported. The and juicy appearance of the roselle is diminished by being too long in the hands of the dealer, but this does not indicate deterioration of its useful qualities.

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[a] Bul. 171, Office of Experiment Stations, p. 38.

COMPOSITION AND USES OF THE FRUIT.

In the roselle it is the large, reddish, fleshy calyces surrounding the seed pod that are used for food. As already stated, a considerable industry has lately been developed in Queensland, where the fruit is made into jam and exported. There is no reason why a similar industry should not grow up in the United States. The usefulness of the roselle as a substitute for cranberry sauce has been emphasized already, and its qualities for making jelly are unexcelled. In the United States it would probably become of greatest importance in the manufacture of jelly.

An analysis of the calyx was made by the food laboratory of the Bureau of Chemistry, which at the same time made an analysis of the cranberry for comparison, the uses of the two fruits being so similar. It will be seen from these analyses (see table below) that the constituents of the two fruits occur in nearly the same proportions, practically the only difference being that traces of benzoic acid in some form are present in the cranberry, while absent from the roselle.

*Comparative analyses of the composition of the roselle and the cranberry.**

	Roselle.	Cranberry.
	Per cent.	*Per cent.*
Water	88.91	88.53
Solids	11.09	11.47
Ash	.89	.25
Marc (insoluble matter)	6.67	4.60
Acid (as malic)	2.77	2.74
Reducing sugar as invert	.33	1.90
Sucrose	.03	.10
Benzoic acid	Absent.	Present.
Starch	Absent.	

* Weight of fruit of roselle, 6.11 grams; cranberry, 0.94 gram. Percentage of edible portion: Roselle, onsisting of calyx minus the portion of its base which is cut away in removing the seed pods, 50.22; ranberry, 100.

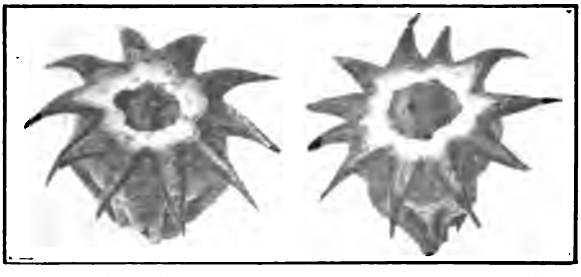

FIG. 6.—Calyces of the roselle prepared for cooking by removal of seed pod. (Four-fifths natural size.)

In preparing for cooking, take the pod between the thumb and refinger of the left hand, stem end up; cut off the stem and the asal end of the cayx to where the seed od is united with he calyx, when a ight pressure with he fingers holding he pod will force ut the seed pod. ee fig. 6.) After eparing in this ay, the calyx may used for making sauce, jam, and transparent, bright red jelly. any other dishes will suggest themselves to the thrifty housewife.

The calyces may also be separated from the seed pods and dried in the sun or in an evaporator, and are in this form, according to Mr. O. F. Cook,[a] occasionally seen in the markets of the Tropics. The juice of the calyces could probably be boiled to a sirup and used as a flavoring extract at soda fountains, and the fruit might also be used in coloring jellies, jams, or similar products as a substitute for coal-tar dyes where a bright red color is desired.[b]

USE OF THE PLANT FOR FIBER.

While this paper has been prepared primarily with reference to the utilization of the fruit of the roselle, the plant is, as previously stated, grown in India for its fiber, which is used in the manufacture of cordage and coarser textile products. Considered from this standpoint, the plant without further breeding could be cultivated over a large area in the Southern States, as the crop would be harvested before it was damaged by early frosts. On account of the vigor of the plant and its easy cultivation it is well worth a trial with this end in view. "For this purpose the crop is cut while in flower, dried, made into bundles, and soaked in water for fifteen or twenty days. It is then possible to wash out a strong silky fiber known in commerce as roselle hemp, considered by some to be the equal of jute. The leaves are sometimes used as a salad and the seeds are supposed to have medicinal properties. They are also fed to cattle and poultry."[c]

BREEDING.

The roselle is an annual, and consequently seed must be saved every autumn for planting the next spring. To improve the strain the grower should go over his field repeatedly when the fruit is setting and tag such plants as combine great vigor with large bearing capacity and have calyces large and well formed. To obtain the best results in a comparatively short time it would be expedient to bag and hand-pollinate the flowers. When the seed pods turn yellow they should be gathered from time to time and dried, after which they are easily thrashed out. Keep the seed in a dry place secure from moths and rats.

During a long period of cultivation nearly all of our vegetables have become so domesticated that they may be forced to grow and produce at will where frostless conditions prevail; hence we have fresh tomatoes, eggplants, etc., in midwinter in the South. The roselle, not having had this advantage, can at present be cultivated only where frost is unknown, or nearly so, as its growing period is very long and its blooming and fruiting season extends late in the year. Should it, however, be found desirable to grow the plant in temperate climates, there is no reason to doubt that the roselle would adapt itself to shorter summers. Its near relative, Sea Island cotton, is a striking illustration of how a plant may adapt itself to entirely new conditions, and the following quotations from Dr. H. J. Webber are, in this instance, of timely interest:

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[a] Contributions from United States National Herbarium, Vol. VIII, pt. 2, p

[b] After this bulletin was prepared the writer was informed by Mr. W. W. Tracy, of the Bureau of Plant Industry, that he, together with Mr. Coulter, made from the small and tender branches several years ago. He adds that the leaves picked off before boiling the stems.

[c] Contributions from the United States National Herbarium, Vol. VIII, pt. 2, p

> According to tradition and the reports of growers, Sea Island cotton when first introduced into this country from the West Indies was a perennial unsuited to the duration of the seasons of the latitude of the Sea Islands off South Carolina and Georgia, where it seldom matured fruit. However, through the selection of seed from early maturing individual plants and through better methods of culture, there has developed an improved race which now seems to be thoroughly adapted to the conditions of growth in the regions referred to. Furthermore, under the continuous and rigorous selection o which the plants have been subjected, the fiber has gradually improved, and now hat produced along the coast and on the islands lying off South Carolina and Georgia s considered superior to that grown in any other part of the world. The custom of arefully selecting the seed has grown with the industry, and may be said to be inseprable from it, and it is only by such careful selection that the staple can be kept up o its present superior excellence. Several different strains have been developed, nd are maintained by different growers selecting with different ideals in view. * * This method and similar ones employed by numerous other growers are pplicable, with slight variations, to most of our common crops, such as corn, wheat, c.[a]
>
> About 1,785 seeds of this cotton were brought to Georgia from the Bahamas. Notithstanding the good care they received and the mild winter, the plants were killed wn, but they came up again from the roots and with this start succeeded in ripening few seeds before the first frost in the fall. The earliest of these seeds were sown turn and by continuing this process of selection the flowering period became earlier d earlier, until now the plants ripen a large proportion of their seeds before frost, en along the coasts of the Carolinas. Besides striving to obtain earlier maturing ts, very careful selection has for years been made with a view to increasing the gth, fineness, and strength of the staple. The selection is regularly practiced by intelligent growers and to-day it may be regarded as one of the necessary cultural thods. Every year a special patch of cotton is grown from selected seed; the plants this patch are examined very carefully and the seed of the best individuals retained planting a similar patch next year, the seeds of the remaining plants being used plant the general crop. Under such continuous and rigorous selection the length fineness of the fiber have gradually increased until it is now recognized as superior that grown anywhere else in the world and commands the highest price in the rket.[b]

Vith the object in mind of breeding an early-ripening variety of roselle the breeder might find it expedient to harvest some of the d before it is fully mature, as it has been shown that plants from en seeds—tomatoes, for instance—have a tendency to mature t earlier than plants from ripe seeds.

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[a] Yearbook, Department of Agriculture, 1898, p. 358.

[b] Yearbook, Department of Agriculture, 1899, p. 490.

FUNGOUS DISEASES AND INSECT ENEMIES.

The only disease that has so far been noted on the roselle is a mildew (*Oidium* sp.) which attacks all parts of the plant above ground and under favorable conditions appears capable of doing considerable damage in discoloring the fruit and in lessening the vitality of the plant. (See figs. 3 and 4, showing mildew on the calyces.) Where its presence was noted, however, the greater part of the crop was gathered before the mildew made its appearance, making the loss of fruit comparatively small. Experiments have not been made to find a remedy, but sulphuring the plants would probably be found to be effective. Bordeaux mixture would without doubt prove efficacious, but would also in all probability tend to discolor the manufactured product.

The most serious enemy of the roselle is the root-knot nematode (*Heterodera radicicola*). A cheap and effective remedy for this pest has not yet been found and infested lands should not be planted with the roselle.

The soft scale (*Coccus hesperidum*) has been noted on the roselle, but has not yet assumed the character of a pest. Its activity is restricted to the stem and lateral branches close to the ground. The scale is distributed by a small black ant.

The cotton stainer (*Dysdercus suturellus*) has been observed on the plants in limited numbers, but does not appear to be injurious.

The yellow aphis (*Aphis gossypii*) has been known to do considerable damage on individual plants by attacking the leaves and flower buds and causing the calyces to drop. It has not, to the knowledge of the writer, appeared as a serious pest. Remedies for this species, better known as the melon or cotton aphis, are considered in Circular No. 80 of the Bureau of Entomology of this Department.

SUMMARY.

The roselle is an annual from the Old World Tropics.

It is extremely sensitive to frosts, and can at present be grown for its fruit only in tropical and subtropical countries.

Being easily cultivated when the climate is favorable, the roselle should be in the garden of every family, and on account of its excellent qualities for making jellies, jams, etc., it is certain to become an important plant in the manufacture of those products.

The young stems also make good jelly. For such use the plant can be grown almost anywhere in the North or South.

By proper methods of breeding it is possible to obtain strains with larger calyces. Probably earlier bearing races can also be obtained by careful selection of the earliest flowering plants.

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Issued September 7, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 308

GAME LAWS FOR 1907.

A SUMMARY OF THE PROVISIONS RELATING TO SEASONS, SHIPMENT, SALE, AND LICENSES.

BY

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(Revised edition, October, 1907.)

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., August 27, 1907.

Sir: I have the honor to transmit herewith for publication in the series of Farmers' Bulletins a summary of the game laws for 1907 relating to seasons, shipment, sale, and licenses, prepared by T. S. Palmer, Henry Oldys, and Charles E. Brewster, of the Biological Survey. This bulletin is similar in scope to those issued annually since 1902 and includes changes in the laws made during the present year. The information here given is greatly condensed in order to present the essentials of the laws as compactly as is compatible with clearness. The section relating to legislation includes references for most of the new laws and a summary of the more important bills under consideration which failed to pass—features which are believed to be of special value to those interested in game protection.

Respectfully,

H. W. Henshaw,
Acting Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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GAME LAWS FOR 1907.

INTRODUCTION.

SCOPE OF THE BULLETIN.

The object of the present bulletin is to present in convenient form a summary of the game laws of the United States and Canada which govern seasons, shipment, sale, licenses, and limitations on amount that may be killed. Its purpose is, primarily, to furnish information concerning restrictions on trade in game, knowledge of which is necessary in the enforcement of the Federal statute regulating interstate commerce in game, commonly known as the Lacey Act. Hence such provisions as relate to methods of capture of game, enforcement of laws, disposition of fines and fees, and such matters as are of special or local application are not included. These may be found elsewhere, either in summaries prepared for the use of sportsmen by game associations, railroad companies, and private publishers, or from the laws themselves, which in most cases may be had in separate form from State game officials[a] or secretaries of state.

The demand for a publication containing a concise summary of existing game laws, both Federal and State, apparently increases in direct proportion with interest in game protection, and the need of such a summary constantly grows with the increasing complexity of game legislation and the prevalence in some States of county laws. In Maryland and North Carolina the legislatures enact separate laws for the different counties; in New York, Oregon, and Washington laws for different districts or sections of the State are fairly numerous and are becoming more so. In Louisiana the close season for deer must be fixed by the police jury of each parish, and in Nevada and Virginia county officers are empowered to shorten or shift open seasons. In the following tables such local laws and regulations are included as fully as possible, but as some are inaccessible and others are likely to be changed at any time an absolutely complete and accurate summary of them is impracticable.

LEGISLATION OF 1907.

In 1907 regular legislative sessions were held in all of the States and Territories except seven[b]—Kentucky, Louisana, Maryland, Mississippi, Ohio, Oklahoma, and Virginia—and also in all the Provinces of Canada. Game bills were under consideration in each of these States and Provinces and new laws were passed in all except Arizona, Georgia, Nevada, New Jersey, North Dakota, and British Columbia. Including the 71 local laws passed in North Carolina, the statutes affecting game numbered in all about 180. Several States, including Alabama, Missouri, Texas, and Utah, adopted entire new game laws, and Alabama, South Dakota, and West Virginia passed the American Ornithologists' Union law giving complete protection to nongame birds.

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[a] A directory of these officers with their addresses and a list of the commissions which issue fish and game laws in separate form may be found in Circular No. 62 of the Biological Survey, U. S. Department of Agriculture, 1907.

[b] In the following résumé the acts of Vermont are included, as the session of its legislature in 1906 occurred too late in the autumn to incorporate the changes in the game law bulletin of that year.

In the number of bills introduced and in the general demand for change of some sort the record of 1907 is second to that of no previous year, although the number of bills actually passed was equaled by the legislation of 1905. In spite of the large number of bills introduced there was a manifest tendency toward conservatism. Most of the changes of season were made with a view of securing greater protection. In several States the seasons were closed entirely for certain kinds of game, and in others measures were allowed to fail rather than pass in an unsatisfactory form. Much attention was given to licenses as a means of providing funds for game protection, and also to legislation extending or strengthening the warden service.

Among the novel or more striking features of the year's legislation were acts prohibiting the use of automatic guns for the hunting of game in Pennsylvania, New Brunswick, and Ontario; establishing an elective office of game commissioner in Alabama; providing for an optional license in Tennessee for a resident hunting with verbal permission on lands where otherwise he would have to obtain written consent; authorizing rewards for information leading to conviction for killing big game in Wyoming, and the increase in such rewards in Minnesota; requiring the State warden of Idaho to investigate means of destroying noxious animals; providing that all heads of big game secured in Alberta must be stamped or branded by the department of agriculture before being sold; requiring that anyone who kills a deer in Vermont must report the fact and exhibit the head to the nearest game warden; limiting hunting and lumber camps in Maine to the use of 6 deer a season; applying the residue over and above expenses of the game-protection fund in Missouri to the improvement of roads; and limiting hunting by able-bodied men in two Florida counties to taxpayers.

Licenses.—The license system was adopted for the first time in Alabama, California, Connecticut, Rhode Island, and Texas. Alien licenses were established in Alabama, California, Connecticut, Maine, New Hampshire, South Carolina, Texas, and Utah; nonresident licenses in Alabama, California, Connecticut, Massachusetts, Rhode Island, and Texas, and resident licenses in Alabama, California, Connecticut, Tennessee, and Utah. Michigan, Vermont, and Wyoming established bird licenses, and Alberta and Nova Scotia guide licenses. Nova Scotia and Ontario made provision for licenses for guests of residents, Missouri changed its State license to a county license, and Tennessee and Alberta provided licenses for game dealers, that of Tennessee being graduated in fee according to the population of the town in which it might be used. Two optional licenses were established, that of Tennessee already mentioned, and a license for hunting deer in New Brunswick, the issue of which was made discretionary by the surveyor-general of the Province. Prince Edward Island provided a special license for nonresidents paying taxes on real estate valued at $325 or more, Massachusetts and Rhode Island adopted identical provisions permitting members of existing fishing and hunting clubs to secure nonresident licenses on payment of a fee of $1. Ontario increased the nonresident fee from $25 to $50, and Saskatchewan increased the fees charged nonresidents for hunting big game and birds from $25 to $100 and from $15 to $50, respectively. Three counties in Florida established special licenses. As a result of the year's legislation, hunting licenses of some sort are now required in all the provinces of Canada and all the States and Territories, except Alaska, Arkansas, District of Columbia, Georgia, Indian Territory, Nevada, New Mexico, and Oklahoma.

Warden service.—In the legislation of the year a notable tendency is observable toward consolidation of the related offices of fish, game, and forestry protection. Michigan added forestry to the duties of the game and fish warden, with an increase of salary from $2,000 to $3,000. Montana made the State warden ex officio fire warden and a member of the board of fish commissioners, increasing the salary from $2,000 to $2,400. Texas extended the duties of the fish and oyster commissioner to include game, with an increase from $1,800 to $2,500 in salary, and with provision for a deputy in charge of game matters at $1,800. Ontario abolished the game commission and combined the work of fish and game protection under the charge of the former chief warden, changing his title to superintendent of game and fisheries. (An attempt was likewise made in Washington to consolidate game, fish, and forestry protection, but the proposed measure failed to pass.) Increases in the number of salaried deputies were also made in several States. In Illinois the district wardens were increased to 16, in New York the protectors from 65 to 75, Montana added 4 district wardens to the force already employed, and Michigan 10 district deputies.

Preserves.—In several States measures were enacted to encourage propagation of game or to provide for the establishment of State or private preserves. In California the State fish commissioners were authorized under certain conditions to set aside private lands as State game preserves. Massachusetts made an appropriation for the acquisition of lands on Marthas Vineyard as a preserve for the heath hen, and authorized the use of a part of the Middlesex Fells for the establishment of a zoological park. Minnesota gave absolute protection to wild animals and birds on State forest reserves, lands, and parks. Pennsylvania prescribed that State game preserves should not exceed 9 miles in circumference, or be located within 25 miles of each other; that there should be a perpetual close season for game and wild birds upon them; and that it should be unlawful to take firearms or dogs upon such preserves at any time, or to enter them during the open season for game. Alberta established two Provincial preserves; and Indiana, Illinois, North Carolina, and Vermont adopted provisions specially exempting from certain restrictions deer raised in private preserves.

Miscellaneous.—Among the miscellaneous provisions adopted should be mentioned the authorization by Pennsylvania and Wisconsin of the confiscation of boats and other appliances used in unlawful hunting and the provision made by New Hampshire, Massachusetts, Rhode Island, and New Brunswick, permitting the use of shotguns in protecting crops from the depredations of deer.

NEW LAWS PASSED IN 1907.

Alabama.—One act: Providing a State game and fish commissioner at $2,500 per annum to be elected every four years, shortening seasons, fixing bag limits, prohibiting all export and sale, requiring $1 and $3 resident and $15 nonresident and alien licenses, and giving complete protection to nongame birds (No. 18).

Alaska.—No legislation.

Arizona.—No legislation.

Arkansas.—Laws not received.

California.—Four acts: Establishing $1 resident, $10 nonresident, and $25 alien licenses (ch. 206); altering the deer and dove seasons, opening a season for gray squirrels, placing a bag limit on squirrels and reducing that on ducks, removing protection from all fish-eating birds, encouraging the establishment of private preserves by authorizing the posting of private lands and having them registered with and controlled for 1 to 5 years by the State board of fish commissioners for such purpose (ch. 433); and requiring that artesian wells be kept capped except when used for irrigating purposes, thus restricting use of water by ducking clubs.

Colorado.—Three acts: Providing for a deputy game and fish commissioner, extending close seasons for elk, antelope, mountain sheep, and crested quail, permitting the hunting of does and fawns, giving absolute protection to wild turkeys and wild pigeons and a close season to plover, shortening curlew season, and reducing number of ducks allowed in possession at one time from 100 to 50 (chaps. 185, 186, 187).

Connecticut.—Four acts: Extending prohibition of sale of quail, grouse, and woodcock to 1911 (ch. 70); reducing the bag limit on rail and prohibiting spring shooting of snipe and shore birds (ch. 71); and of waterfowl (ch. 72); providing a hunting license system with fees of $1 for residents, $10 for nonresidents, and $15 for aliens, the proceeds to be used for the preservation and propagation of game (ch. 153).

Delaware.—One act: Prohibiting shooting of ducks on Indian River and Rehoboth Bay from boats not propelled by oars.

District of Columbia.—No legislation.

Florida.—Five local acts: Affecting seasons and hunting licenses in Clay County (ch. 5775), seasons, licenses, bag limits, and warden service in Hernando County (ch. 5776), and licenses and warden service in Sumter County (ch. 5783); and limiting the right to hunt to taxpayers in Taylor (ch. 5783) and Wakulla (ch. 5784) counties.

Georgia.—No legislation.

Hawaii.—One act: Providing for protection of birds beneficial to forests (ch. 104).

Idaho.—Three acts: Strengthening the warden system, providing for capturing game for propagation or scientific purposes, permitting shipment within the State and export of bag limit by resident licensees, restricting cold storage of game, and shortening seasons of practically all game (pp. 112, 475); and providing for the extermination of predatory animals (p. 301).

Illinois.—One act: Strengthening the warden service, adding a number of imported birds to the game list, extending the close seasons for grouse, pheasants, and wild turkeys for several years, shortening the squirrel season, reducing bag limits, and authorizing the trapping of game for propagation or restocking purposes (p. 344).

Indiana.—Three acts: Increasing protection of squirrels (ch. 94), woodcock, doves and ducks, removing protection from rabbits, reducing bag limits, permitting resident farmers to hunt on their own lands without license, providing for restocking game from the proceeds from resident licenses, increasing restrictions on cold storage (ch. 216), and exempting deer raised in private parks from protection (ch. 219).

Indian Territory.—No legislation.

Iowa.—One act: Giving complete protection to English and Chinese pheasants to 1915 (ch. 134).

Kansas.—Five acts: Giving complete protection to Hungarian partridges and English and Chinese pheasants for six years (ch. 218); increasing protection of prairie chickens in Butler County (ch. 220) and of quail, grouse, and prairie chickens in Rawlins County (ch. 221); prohibiting sale of refrigerated undrawn poultry and game (ch. 187); and providing for extension of the State fish and game hatcheries (ch. [illegible]

Maine.—Four general acts: Giving complete protection to squirrels for four years (ch. 85); extending the duck season (ch. 158); limiting export of deer by residents to one a season, permitting residents to export 6 partridges, 10 woodcock, and [illegible] ducks under a $5 export license for each species, allowing 6 deer a season to each lumber camp (ch. 181); and providing a $15 alien license (ch. 118). Five special acts: Increasing protection of deer in the town of Isle au Haut (ch. 63) and in the counties of Cumberland (ch. 414) and York (ch. 430), and extending the season for golden-eyes in Hancock County (ch. 281) and for all ducks in Lincoln County (ch. 373).

Massachusetts.—Eleven acts: Protecting gulls (ch. 99), loons and eagles (ch. 118), and hawks and owls (ch. 250); abolishing the special seasons in Bristol County (ch. 161); shortening the squirrel season (ch. 166); establishing a $10 nonresident license with exemptions in favor of nonresident owners of real estate and members of existing fishing and hunting clubs (ch. 198); restricting duck hunting in Dukes County (ch. 264); authorizing the protection of crops from deer (ch. 307); providing for establishing a refuge on Marthas Vineyard for the heath hen (ch. 504), and making minor changes (chaps. 299, 300).

Michigan.—Seven acts: Adding forest protection to the duties of the State warden and increasing his salary to $3,000 (No. 264); increasing the warden force (No. 448); protecting European partridges for five years (No. 271); altering arrangements for transporting deer after end of season (No. 468); providing a $10 nonresident small-game license (No. 529); and making minor changes in the season for waterfowl (Nos. 301, 495).

Minnesota.—Three acts: Increasing the salary of the executive agent to $2,500, providing for rewards for convictions for illegal hunting, exempting from license requirement residents not over 21 years old, making resident licenses expire Dec. 15, and altering a few other details of the old law (ch. 469); authorizing arrest without warrant, prohibiting use of firearms within 3 miles of cities with population of 50,000 (ch. 300); and giving absolute protection to wild animals and birds on State forest reserves, lands, and parks (ch. 45).

Missouri.—Two acts: Abolishing regular deputy wardens, prohibiting export of game from county except a limited bag by a sportsman, permitting sale of imported game during open season and of domestic game in county of capture, penalizing the sale of game under a false name, permitting hunting without license in county of residence and providing special $1 licenses for hunting in adjoining counties and $2.50 county licenses for rest of State, restricting the nonresident license to the county of issue, removing protection from does and fawns, changing the squirrel and turkey seasons, closing the season for prairie chickens for three years (p. 277); and providing for calling a grand jury in each county at least once a year to investigate game-law violations (p. 320).

Montana.—Three acts: Making the State warden ex officio fire warden and a member of the board of fish commissioners and increasing his salary to $2,400 (ch. 147); opening a season for antelope with a bag limit of 1 a season (ch. 166), and lengthening the deer season fifteen days (ch. 124).

Nebraska.—One act: Prohibiting sale of all game, shortening seasons, curtailing bag limits, and giving absolute protection to deer and antelope, with a $100 fine for their unlawful killing.

Nevada.—No legislation.

New Hampshire.—Four acts: Giving absolute protection to gray squirrels to 1913 (ch. 76 ; permitting the hunting of deer only with shotguns, opening a season for deer in the southern half of the State, permitting protection of crops from deer (ch. 130); adding woodduck, Bartramian sandpiper, and killdeer to the list of protected game birds (ch. 52); increasing real estate holding necessary for exemption from nonresident license requirement, shortening quail, ruffed grouse, woodcock, and Wilson snipe season, and lengthening those for other upland game, shorebirds, and ducks, and establishing an alien license (ch. 36).

New Jersey.—No legislation.

New Mexico.—One act: Changing seasons for deer, doves, and quail, and authorizing the county commissioners to extend the open season for quail two months in any precinct on petition of 25 resident householders (ch. 105).

New York.—Six acts: Making the deer season two weeks earlier (ch. 668); modifying the transportation season conformably (ch. 666); increasing the number of game protectors from 65 to 75 (ch. 519); and making minor changes relating to rewards (ch. 96) and seasons in Dutchess County (ch. 92) and Lewis County (ch. 48).

North Carolina.—Seventy-one local acts, the most important of which were four prohibiting the hunting of deer and pheasants (ruffed grouse) to November 1, 1910, in 7 counties, with an exemption authorizing the killing, sale, and use of deer raised in preserves (ch. 358); establishing close seasons for deer and ducks in Beaufort County (ch. 384), for deer in Hertford County (ch. 423), and for upland game birds in Columbus County (ch. 505).

North Dakota.—No legislation.

Oregon.—Four acts: Opening the season for male deer one month earlier (ch. 182); protecting quail and Mongolian pheasants until January 1, 1912, in Grant, Harney, Wheeler, Gilliam, and Umatilla counties (ch. 85); repealing the special season for quail, partridges, and pheasants in Douglas County (ch. 98), and giving absolute protection to ringneck pheasants in Jackson County (ch. 23).

Pennsylvania.—Seven acts: Establishing game refuges on State forest reservations (No. 64); extending spring shooting of waterfowl, abolishing the bag limit on waterfowl, and authorizing confiscation of decoys, guns, boats, and all other contrivances used in violation of law (No. 57); lengthening the seasons for rabbits (No. 62) and ruffed grouse (No. 63); giving complete protection to does and fawns (No. 61) and all birds and game within the limits of State preserves (No. 64); increasing protection of nongame birds (No. 149), and prohibiting use of automatic guns (No. 244).

Rhode Island.—Two acts: Establishing a $10 nonresident license with exemptions in favor of nonresident real estate owners and members of existing fishing and hunting clubs (ch. 1456), and permitting protection of crops from deer under permit of the secretary of state (ch. 1455).

South Carolina.—Two acts: Incorporating the Audubon Society of South Carolina with powers of a game commission, providing for wardens, prohibiting export except a limited amount under nonresident license, requiring the marking of packages of game, providing for a game-protection fund, substituting a $10 nonresident State license for the $25 county license and the special license for hunting on navigable waters (ch. 315), and lengthening the deer season in Dorchester County (ch. 228).

South Dakota.—One act: Giving complete protection to nongame birds.

Tennessee.—One act: Extending absolute protection of deer to 1911, shortening the quail season, establishing a $3 resident license for hunting on another's lands under verbal permit, and providing graduated dealers' licenses with fees ranging from $5 to $25, based on population of towns where used (ch. 185).

Texas.—Two acts: Extending the game law, which would have expired in 1908 (ch. 345), enlarging the office of fish and oyster commissioner to cover game, providing a chief deputy commissioner and deputy wardens, establishing a $15 nonresident license and allowing licensee to take one day's bag out of the State, protecting absolutely antelope, mountain sheep, prairie chickens, and Mongolian and English pheasants until 1912, reducing the bag limit on deer and wild turkeys, placing robins and chachalacas on the game list, and changing the dove and turkey seasons (ch. 379).

Utah.—One act: Modifying appointment of wardens, establishing a $1 resident license, reducing the nonresident and alien license from $25 to $10, permitting residents to shoot two deer each in October (nonresidents can not hunt them at any time), altering the seasons for grouse, prairie chickens, sage hens, and doves, and for quail in the Great Salt Lake region, protecting quail in Garfield County, extending absolute protection of elk, antelope, sheep, and introduced game to 1911, permitting limited sale of shore birds and waterfowl, and authorizing scientific collecting of birds and eggs (ch. 118).

Vermont.—Five acts: Strengthening the warden service, requiring any person killing a deer to report the fact and exhibit the head to the nearest deputy game warden, permitting killing at any time of deer in private game preserves, shortening the seasons for upland game and shorebirds, providing a close season for gray squirrels, and making exemption from the nonresident license requirement in favor of real estate owners (No. 152); giving increased financial support to the office of fish and game commissioner (No. 153); establishing a nonresident $5 game bird license (No. 155); providing for payment for damages done by deer (No. 156), and removing sale restrictions from game from private game preserves stocked at the owner's expense (No. 157).

Washington.—One act: Opening a 3-months' season for Chinese pheasants east of the Cascades corresponding with that in effect west of the Cascades, permitting the killing of deer on islands, except game preserves, during October, and protecting bobwhite quail and Chinese pheasants in Okanogan County to 1912 (ch. 222).

West Virginia.—One act: Giving complete protection to nongame birds (ch. 57).

Wisconsin.—Eleven acts: Giving absolute protection to moose throughout the State and to deer in 36 counties, reducing the bag limit on deer for nonresidents to 1 (ch. 259) and the export limit to 1 (ch. 311); prohibiting hounding and forbidding possession of dogs in hunting and lumber camps, in the deer country (ch. 201); increasing protection of quail, grouse, and imported pheasants (ch. 627); providing bag and export limits on grouse, shore birds, and waterfowl, increasing restriction of shipment in or from the State (ch. 586); prohibiting the use of a rifle in hunting waterfowl other than goose or brant, authorizing confiscation of boats (ch. 415); and making minor changes (chaps. 287, 315, 544, 567, 611).

Wyoming.—Four acts: Making head hunting and tusk hunting a felony and authorizing the payment of $300 rewards for detection of violations of the act (ch. 47); limiting absolute protection of quail and Mongolian pheasants to end in 1912 (ch. 35); shortening the seasons for grouse, prairie chickens, and sage chickens, establishing a $1 bird license for residents, extending the $2 big game resident license to cover birds, and reducing the bag and export limits on big game from 2 to 1 (ch. 102); and prescribing details of issuing licenses (ch. 36). The legislature also memorialized the "Benevolent and Protective Order of Elks" to discourage the use of elk tusks.

Alberta.—One act: Closing seasons for elk, sheep, goat, and upland game, and shortening the season for big game; establishing two Provincial game preserves; giving comprehensive protection to nongame birds; providing export permits at $5 for each big game trophy and $1 for 12 game birds; permitting limited export for propagation under $5 permit; requiring that heads of big game be stamped by minister of agriculture before being sold, at fees of $5 for elk, caribou, moose, and sheep, and $2 for deer, antelope, and goat; placing bag limit of 2 on antelope; providing licenses for guides at $5, game dealers and trappers at $10, and residents at $2.50; increasing guest license to $2, and repealing exemption of Indians from the game laws.

British Columbia.—No legislation; a few local restrictions made by orders in council.

Manitoba.—One act: Giving absolute protection to buffalo and to the females of deer, antelope, elk, moose, and caribou (ch. 66).

New Brunswick.—One act: Establishing a $10 bird license, providing for the issue of a $10 deer license at the option of the surveyor-general, prohibiting employment of nonresident guides, reducing from 5 to 2 the number permitted to employ one guide, requiring guides to report the number of game animals of each species killed by their parties, authorizing the return of the license fee for ladies who have accompanied hunting parties but have killed no game, prohibiting the use of automatic guns, and permitting the killing of deer in protection of crops (ch. 40).

Newfoundland.—One act: Prohibiting all hunting of caribou in a certain region on Grand Lake, increasing the fee for a nonresident guide license from $25 to $50, and permitting sale at any time of ptarmigan or willow grouse killed in open season.

Nova Scotia.—One act: Shortening seasons for moose, shore birds, and waterfowl, opening a 6-months' season for upland game birds, including capercailzie, blackcock, and chukar partridge, closing the season for four years for ruffed grouse and spruce partridge on Cape Breton Island, prohibiting sale of deer and caribou to 1910, permitting limited export for propagation, providing a $2 guide license, and requiring moose hunters to report each moose killed to the Game Society (ch. 27).

Ontario.—One act: Substituting a superintendent of game and fisheries for the board of game commissioners and reorganizing the warden service, opening a 3-months' season for pheasants, partridges, and prairie chickens, and making minor changes in other seasons, penalizing the sale of game under a false name, further increasing the discretionary powers of the lieutenant-governor-in-council, prohibiting the use of automatic guns, licensing the carrying of guns by persons engaged in constructing railways or other public works, and further restricting cold storage of game (No. 1371).

Prince Edward Island.—One act: Establishing licenses at $2.50 for nonresident sons and brothers of residents, at $2.25 for guests for a specified number of days, and at $5 for nonresident real estate owners; permitting licensee to export 12 birds, placing wild turkey and curlew on the game list, and extending seasons for woodcock, snipe, and plover.

Quebec.—No legislation.

Saskatchewan.—One act: Providing for a chief game guardian and subordinates, shortening the season for big game, and abolishing the special season in the southeast part of the Province, prohibiting spring shooting of waterfowl and shore birds, ncreasing the nonresident licenses from $15 and $25 to $50 and $100, respectively, educing bag limits on big and upland game, and permitting export of game for propagation on application from governments of other Provinces or States (No. 23).

Unorganized Territories.—Laws not received.

Yukon.—Laws not received.

BILLS WHICH FAILED TO PASS.

Among the numerous measures which failed to pass, or to receive he approval of the governor, were some which contained novel features or features of special interest. More than the usual number of ame bills were vetoed. In California a bill establishing a game comission and another providing for the celebration of bird day in the chools passed the legislature, but failed to receive the approval of he governor. In New York a dozen or more game bills failed to eceive approval of the governor, among them being a bill carrying n appropriation of $20,000 for the establishment of a herd of buffalo the Adirondack Park, which was vetoed,[a] and a bill protecting gray squirrels throughout the year. In Oregon a bill allowing fruit growers to destroy birds supposed to be injuring their crops at any season was likewise vetoed.

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[a] See Forest and Stream, July 20, 1907, p. 88

Practically nothing was accomplished in the way of Federal legislation, as a bill to amend the Alaska game law by providing a system of nonresident licenses passed the House but failed in the Senate a few minutes before adjournment, and none of the bills to establish game refuges on the National forests made substantial progress.

It is obviously impossible to mention more than a few of the numerous measures considered in the State legislatures, but the following were some of the more important ones which failed: Bills to prohibit the use of automatic guns in hunting game were introduced in Connecticut, Georgia, Illinois, Indiana, Iowa, Maine, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Texas, and Washington, but failed in all the States except Pennsylvania; in Arkansas a bill removing protection from ducks and other waterfowl was introduced but failed to pass; in California, a bill amending the law for the protection of nongame birds; in Delaware, a bill to establish a State game commission for conducting the work hitherto performed by the Delaware Game Protective Association and increasing the nonresident license from $5 to $10; in Illinois, a bill permitting shooting on submerged lands (Forest and Stream); in Iowa, a bill to establish resident licenses, which passed the house but failed in the senate; in Florida, three bills to establish the office of State game commissioner, to provide a warden system, and to revise the general game laws; in Maine, a measure excluding firearms from the woods during close season; in Michigan, bills extending the close season for quail and licensing private preserves; in Minnesota, a universal license for residents hunting in their own counties; in Montana, three bills, (*a*) abolishing the office of State warden and the special game protection fund, (*b*) abolishing the office of deputy warden and giving State wardens jurisdiction over peace officers, and (*c*) abolishing the office of State warden and providing for an elective office of county game warden and stock inspector; in New Jersey, measures prohibiting spring shooting of waterfowl and summer shooting of woodcock, establishing a resident and alien license system, and prohibiting all sale of game; in New York, a bill authorizing the sale of certain imported game from December to April, inclusive, and a bill providing for a $1 resident and $20 nonresident license; in North Carolina, a bill charging nonresidents $100 for shooting in Currituck Sound; in North Dakota, a general bill amending the game law, stopping spring shooting, establishing licenses, and protecting nongame birds; in Pennsylvania, a bill to establish a resident license; in South Dakota, law closing the quail season for several years, which passed the legislature but failed to receive the sanction required by its referendum clause; in Washington, a bill to create a State game commission composed of the governor, State fire warden, and the fish commissioner; and a bill (H. 155) to prevent hunting accidents by imposing a penalty of $1,000, or imprisonment not exceeding 10 years, for killing persons accidentally; in West Virginia, amendments to the general game law; in Wisconsin a bill to permit spring shooting of waterfowl; in Wyoming, all efforts to protect the antelope; in Alberta, the establishment of a reserve for goats; and in British Columbia, all game legisla-

CLOSE SEASONS.

All the general close seasons for game prescribed by the various States and by the Provinces of Canada are here brought together in one table. For the sake of simplicity a uniform method is used in both the arrangement of species and statement of seasons. In each case deer and other big game are first considered; then squirrels and rabbits; then upland game birds, such as quail, grouse, pheasants, turkeys, and doves; then shore birds, and finally waterfowl, such as ducks, geese, and swans. In the statement of seasons only close seasons have been given, and in stating these the plan of the Vermont law, to include the first date but not the last, has been followed consistently.[a] The Vermont scheme has the advantage of showing readily both the open and close seasons, since either may be obtained by reversing the dates of the other.

In some States certain days of the week constitute additional close seasons throughout the term in which killing is permitted. Hunting on Sunday is prohibited in all except four of the States east of the Mississippi, and in Iowa, Kansas, Missouri, Minnesota, Nebraska, North Dakota, and Oklahoma, as well as in most of the Canadian Provinces. Mondays constitute a close season for waterfowl in Ohio and other week days for wild fowl in several favorite ducking grounds in Delaware, Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Baltimore, Frederick, and Harford counties, Maryland. The county laws of Maryland and North Carolina, which are too numerous to be included satisfactorily, are given in detail on pages 49–52, but are not incorporated in the following table, which otherwise may be regarded as a practically complete résumé of the regulations now in force. The difficulty of securing absolute accuracy in a table of this kind is very great, and the absence in the laws of many States of express legislation as to the inclusion or exclusion of the date upon which seasons open and close makes exactness almost an impossibility.

CLOSE SEASONS FOR GAME IN THE UNITED STATES AND CANADA, 1907.

[The close seasons include the first date, but not the last. To find the open seasons *reverse the dates.* easons which apply only to special counties are placed to the left of the column containing the lose seasons for the State in general.]

	Close seasons.
labama (1907):	
Male deer (does protected all the year)	Jan 1–Nov. 1.
Squirrel (black, gray, or fox)	Feb. 1–Sept. 1.
Quail or partridge, dove, rail, coot, mud hen, woodcock, sandpiper, curlew, other shore birds, duck, goose, brant, swan	Mar. 1–Nov. 1.
Wild turkey gobblers (hens protected all the year)	Mar. 1–Dec. 1.
Ruffed grouse (pheasant), imported pheasant or other introduced game birds.	Until Dec. 1, 1912.
Snipe, plover	May 1–Nov. 1.
laska [b] (1902–1904):	
Deer	Feb. 1–Aug. 1.
Moose, mountain sheep	Jan. 1–Sept. 1.

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[a] See discussion of this question in Circular No. 43 of the Biological Survey. U. S. Department of riculture, 1904, entitled "Definitions of the open and close seasons for game."

[b] Game animals or birds may be killed at any time for food or clothing by native Indians or Eskimo, by miners, explorers, or travelers in need of food, but game so killed can not be shipped or sold.

Close Seasons for Game—Continued.

	Close seasons.
Alaska (1902-1904)—Continued.	
Caribou (except on Kenai Peninsula, until Sept. 1, 1908, and in the rest of the Peninsula district[a] Nov. 1-Sept. 1)	Jan. 1-Sept. 1.
Mountain goat	Jan. 1-Aug. 1.
Bear (large brown)	Jan. 1-Apr. 1
Grouse, shore birds	Dec. 16-Sept. 1.
Ptarmigan, waterfowl	Feb. 1-Sept. 1.
Arizona (1905):	
Male deer	Dec. 1-Sept. 15.
Female deer, spotted fawn, elk, mountain sheep, mountain goat	All the year.
Antelope, 6 years	Until Mar. 1 1911
Quail, bobwhite, partridge, grouse, pheasant, snipe, rail	Mar. 1-Oct. 15.
Introduced pheasant (Chinese, Japanese green, golden, ringneck) 6 years	Until Mar. 1, 1911
Wild turkey	Dec. 1-Sept. 15.
Arkansas (1901-1905):	
Deer	Feb. 1-Sept. 1.
Quail or partridge	Mar. 1-Nov. 1.
Pinnated grouse, prairie chicken	Dec. 1-Oct. 31.
Pheasants (Chinese, English), 10 years	Until Mar. 14, 1
Wild turkey	May 1-Sept. 1.
Dove	All the year.
California [b] (1901-1907):	
Male deer	Oct. 1-July 15.
Tree squirrel	Jan. 1-Sept. 1.
Female deer, fawn, elk, antelope, mountain sheep	All the year.
Valley quail, partridge, plover, curlew, ibis, rail, shore birds	Feb. 15-Oct. 1
Mountain quail	Feb. 15-Sept. 1
Grouse, sage hen	To Sept. 1, 19
Pheasants, bobwhite, imported quail or partridge, swan	All the year.
Dove	Oct. 15-July 1
Wilson snipe	Apr. 1-Oct.
Duck	Feb. 15-Oct. 1.
Colorado (1899-1907):	
Deer	Oct. 21-Oct. 1.
Elk, 4 years	Until Nov. 1, 1
Antelope with horns, mountain sheep with horns, 4 years	Until Oct. 15
Antelope and mountain sheep without horns	All the year
Quail (bobwhite, crested), 13 years	Until 1920.
Wild turkey, pheasant, partridge, ptarmigan, wild pigeon, crane	All the year.
Grouse, prairie chicken	Oct. 2-Aug. 2
Sage chicken	Oct. 2-Aug. 1
Dove	Sept. 6-Aug.
Plover, curlew	Oct. 31-Aug. 1
Snipe, shore birds, duck, goose, brant, swan, waterfowl (see exception)	Apr. 16-Sept.
Exception: Altitudes above 7,000 feet — May 2-Sept. 15	
Connecticut (1901-1907):	
Deer, 10 years	Until June
Gray squirrel, hare, rabbit	Dec. 1-Oct.
Quail, ruffed grouse, woodcock, pheasant (Chinese, Mongolian)	Dec. 1-Oct.
Dove	All the year
Plover, Wilson or English snipe, bay snipe, sandpipers, shore birds, gallinule, mud hen, duck, goose, brant, swan	Jan. 1-Sept.
Rail	Jan. 1-Sept.
Delaware (1893-1905):	
Squirrel (other than red, and only in Kent and Newcastle counties), rabbit	Jan. 1-Nov.
Quail, partridge, pheasant	Jan. 1-Nov.
Dove	All the year
Reedbird, ortolan or rail	Feb. 2-Sept.
Duck (except wood duck), goose, brant, swan	Apr. 16-Oct.

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[a] The Territory is divided into three game districts: (1) Sitka district—Southeastern Alaska the 141st meridian; (2) Peninsula district—Aleutian Islands, Alaska and Kenai peninsulas cent islands, and that part of Alaska west of the 141st meridian draining into the Pacific Ocean. Yukon district—Remainder of Territory, including the area drained by the Kuskokwim, Yukon, and Kowak rivers, and the area which drains into the Arctic Ocean.

[b] Seasons fixed by ordinances of boards of county supervisors are omitted (see explanation

[c] Wild fowl on Assawaman Bay and tributaries, Sussex County, May 1-Nov. 1, and on Thursdays, Saturdays, and Sundays in the open season.

Close Seasons for Game—Continued.

	Close seasons.
District of Columbia[a] (1899-1901):	
Deer meat (sale or possession)	Jan. 1-Sept. 1.
Squirrel, rabbit (except English rabbit, Belgian hare)	Feb. 1-Nov. 1.
Quail or partridge	Mar. 15-Nov. 1.
Ruffed grouse or pheasant (except English, ringneck, or other imported pheasants raised in inclosures, sale or possession unrestricted), wild turkey.	Dec. 26-Nov. 1.
Prairie chicken or pinnated grouse	Mar. 15-Sept. 1.
Dove	All the year,
Woodcock	Jan. 1-July 1.
Snipe, plover, duck, goose, brant	Apr. 1-Sept. 1.
Reedbird, marsh blackbird, rail or ortolan, other game birds not previously mentioned	Feb. 1-Sept. 1.
Florida[b] (1903):	
Deer	Feb. 1-Nov. 1.
Quail or partridge, wild turkey	Mar. 1-Nov. 1.
Duck	Apr. 1-Oct. 1.
Georgia (1903-1905):	
Deer	Jan. 1-Sept. 1.
Quail, partridge, pheasant, wild turkey	Mar. 15-Nov. 1.
Dove, snipe, marsh hen	Mar. 15-Sept. 1.
Woodcock, wood duck or summer duck	Feb. 1-Sept. 1.
Hawaii (1905):	
Quail, pheasant	Mar. 1-Sept. 16.
Wild dove, wild pigeon	Feb. 1-July 1.
Imported birds	All the year.
Snipe, plover, turnstone, curlew, stilt, mud hen, migratory duck	May 1-Sept. 16.
Native wild duck, Hawaiian goose	Feb. 1-Sept. 16.
Idaho (1907):	
Deer, elk, mountain sheep, mountain goat	Jan. 1-Sept. 15.
Moose, caribou, antelope, buffalo	All the year.
Quail	Dec. 1-Nov. 1.
Grouse	Dec. 1-Aug. 15.
Partridge, pheasant, turtle dove, prairie chicken	Dec. 1-Sept. 1.
Sage hen	Dec. 1-Aug. 1.
Mongolian pheasant, Canada grouse or fool hen, swan, 4 years	Until Mar. 14, 1911.
Snipe, plover, duck, goose	Jan. 1-Sept. 15.
Illinois (1903-1907):	
Deer,[c] 10 years	Until May 28, 1917.
Squirrel (gray, red, fox, or black)	Nov. 16-July 1.
Quail	Dec. 20-Nov. 11.
Ruffed grouse, prairie chicken, Mexican blue quail, California mountain quail, California valley quail, Hungarian partridge, capercailzie, black grouse, 4 years	Until July 1, 1911.
Wild turkey, pheasants (copper or Soemmering, English, golden, green Japanese, Mongolian, ringneck, silver, tragopan, Reeves, Elliot, Hungarian, Swinhoe, Amherst, melanotte, impeyan, argus), partridge (black Indian, caccabis, chukar), sand grouse, 6 years	Until July 1, 1913.
Mourning dove, woodcock	Dec. 1-Aug. 1.
Jacksnipe or Wilson snipe, sand or other snipe, golden, upland, or other plover	May 2-Sept. 1.
Duck, goose, brant, or other waterfowl	Apr. 16-Sept. 1.
Indiana (1905-1907):	
Deer[d]	All the year.
Squirrel	Nov. 1-July 1.
Woodcock	Jan. 1-July 1.
Quail, ruffed grouse, prairie chicken, or pinnated grouse	Jan. 1-Nov. 10.

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[a] Hunting prohibited in the District, by act of June 30, 1906, except on the marshes of the Eastern anch above the Anacostia Bridge, and on the Virginia shore of the Potomac, provided no birds shot within 200 yards of any bridge or dwelling.

[b] It is unlawful to kill game or game birds within 1 mile of West Palm Beach; similar regulations in force at St. Augustine. Special seasons: Clay County, quail, wild turkey, Mar. 1-Nov. 1 and but 2 days each week rest of year; Hernando County, deer, quail, Feb. 1-Dec. 1, wild turkey, r. 1-Mar. 1, dove, duck, Mar. 1-Dec. 1.

[c] Deer raised in inclosure for market may be killed at any time.

[d] Deer raised in private preserves may be killed at any time.

Close Seasons for Game—Continued.

	Close season.
Indiana (1905-1907)—Continued.	
Pheasants, wild turkey, dove	All the year.
Duck, goose, brant, or other waterfowl	Apr. 1-Sept. 1.
All game except waterfowl	Oct. 1-Nov. 10.
Iowa (1897-1907):	
Deer, elk	All the year.
Squirrel (gray, timber, or fox)	Jan. 1-Sept. 1.
Quail, ruffed grouse or pheasant, wild turkey	Dec. 15-Nov. 1.
Pinnated grouse or prairie chicken	Dec. 1-Sept. 1.
Pheasants (English, Mongolian, Chinese, ringneck)	Until Oct. 1, 19
Turtle dove	All the year.
Woodcock	Jan. 1-July 10.
Sandpiper, plover, rail, marsh or beach birds, duck, goose, brant	Apr. 15-Sept. 1.
Kansas (1903-1907):	
Antelope, 5 years	Until Mar. 13, 19
Red squirrel	All the year.
Quail (see exceptions)	Dec. 15-Nov. 15.
Exceptions: Bourbon, Crawford, Decatur, Finney, Grant, Gray, Greeley, Hamilton, Haskell, Hodgeman, Morton, Rooks, Scott, Sherman, Smith Stafford, Stanton, Stevens, and Wichita counties...... Until Mar. 11, 1908.	
Grouse, prairie chicken (see exceptions)	Oct. 15-Sept. 15.
Exceptions: Prairie chicken in same counties as quail..Until Mar. 11, 1908 Prairie chicken in Butler county, 3 years.............. To Mar. 9, 1910	
Pheasants (English, Mongolian, or Chinese), Hungarian partridge, 6 years	Until Feb. 27, 19
Dove	Sept. 15-Aug. 1.
Plover	Sept. 15-July 15.
Duck, goose, brant	Apr. 15-Sept. 1.
Kentucky (1894-1906):	
Deer	Mar. 1-Sept. 1
Rabbit (except with dogs or in snares)	Sept. 15-Nov. 15.
Squirrel (black, gray, or fox)	Feb. 1-Nov. 15.
Quail, partridge, pheasant	Jan. 1-Nov. 15.
Pheasants (English, ringneck, Mongolian, or Chinese)	All the year.
Wild turkey	Feb. 1-Sept. 1.
Dove	Feb. 1-Aug. 1.
Woodcock	Feb. 1-June 20
Wood duck, teal, or other duck, goose	Apr. 1-Aug. 15
Louisiana (1904-1906):	
Deer (female and young protected all the year)	Local seasons[b]
Quail, woodcock	Mar. 1-Nov. 1
Prairie chicken, wood duck, 5 years	Until July, 19
Male wild turkey (female protected all the year)	Apr. 1-Dec.
Snipe, papabotte	May 15-Aug
Dove, grosbec, surf bird, chorook, sandpiper, plover, tatler, curlew, rail (mud hen), gallinule, coot (poule d'eau)	Mar. 1-Aug
Duck (except wood duck), goose, brant, swan	Apr. 1-Sept.
Maine (1903-1907):	
Deer (see exceptions)	Dec. 16-Oct. 1
Exceptions: Androscoggin County .... Nov. 1-Oct. 1 Counties of Cumberland (females to 1909), Kennebec, Knox, Lincoln, Sagadahoc (except towns of Bath, West Bath, and Phippsburg, all the year), York (females all the year), and Waldo..... Dec. 1-Nov. 1 Hancock County—In towns of Eden, Mount Desert, Southwest Harbor, and Tremont, Dec. 15-Nov. 15; Isle au Haut (on islands) until Feb. 13, 1913, and Swan Island until Dec. 15, 1908; otherwise as in State law.	
Bull moose	Dec. 1-Oct.
Cow and calf moose	All the year
Caribou, 6 years	Until Oct.
Squirrel (gray and black)	Until Ma
Rabbit (except Hancock County)	Apr. 1-
Quail, dove	All the year
Ruffed grouse or partridge, woodcock	Dec. 1-
Pheasant, black game, capercailzie or cock of the woods, 10 years	Until Ap

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[a] Except June 15-Sept. 15.

[b] Close seasons for deer in Louisiana, not less than 7 months in length, to be fixed by [illegible] of the several parishes, but north of latitude 31 the period from May 1 to Aug. 15 [illegible] included.

Close Seasons for Game—Continued.

	Close seasons.
Maine (1903–1907)—Continued.	
Snipe, sandpiper, plover	May 1–Aug. 1.
Wood duck, dusky or black duck, teal, gadwall or gray duck, mallard, widgeon or baldpate, shoveler, pintail or sprigtail, redhead, scaup or greater bluebill, lesser scaup or lesser bluebill, golden-eye or whistler, bufflehead, ruddy duck or broadbill (see exceptions)	Jan. 1–Sept. 1.
Exceptions: Golden-eye (Hancock Co.); ducks (Lincoln Co.)	Feb. 1–Sept. 1
All ducks on the Kennebec River below Gardiner and in Merrymeeting Bay	Dec. 1–Sept. 1
Maryland (1898–1906) (*see county laws, pp. 49–50*):	
Squirrel	Dec. 1–Sept. 1.
Pheasants (English, Mongolian)	Dec. 25–Nov. 1.
Dove	Dec. 25–Aug. 15.
Snipe, plover	May 1–Aug. 15.
Reedbird, sora (water rail or ortolan)	Nov. 1–Sept. 1.
Duck, goose, brant, swan, and other wild fowl	Apr. 10–Nov. 1.
Massachusetts (1902–1907):	
Deer, 5 years	Until Nov. 1, 1908.
Gray squirrel	Dec. 1–Oct. 1.
Hare or rabbit	Mar. 1–Oct. 1.
Quail (see exception)	Dec. 1–Nov. 1.
Exception: Nantucket Island, 3 years	Until Mar. 1, 1908
Ruffed grouse or partridge, woodcock	Dec. 1–Oct. 1.
Prairie chicken, dove, wild or passenger pigeon	All the year.
Pheasants (English, golden, Mongolian), males	Dec. 1–Nov. 1.
Heath hen, wood or summer duck, 5 years	Until 1911.
Bartramian sandpiper (upland plover)	Until July 15, 1910.
Snipe, sandpiper, plover (except upland plover), rail, or any "shore," "marsh," or "beach" birds	Mar. 1–July 15.
Black duck, teal	Mar. 1–Sept. 1.
Other ducks	May 20–Sept. 1.
Michigan[a] (1905–1907):	
Deer (see exceptions)	Dec. 1–Nov. 10.
Exceptions: Deer in red coat and fawn in spotted coat	All the year.
Allegan, Clare, Gladwin, Grand Traverse, Huron, Isabella, Lake, Lapeer, Macomb, Manistee, Mason, Mecosta, Missaukee, Newaygo, Oceana, Osceola, Ottawa, St. Clair, Sanilac, Tuscola, and Wexford counties	Until Jan. 1, 1908
Deer on Bois Blanc Island	Until 1918
Kalkaska County	Until 1910
Arenac, Bay, Benzie, Cheboygan, Emmet, and Leelanau counties	Until 1912.
Elk (see exception), moose, caribou, 8 years	Until June 16, 1913.
Exception: Elk on Bois Blanc Island	Until 1918
Squirrel (black, fox, or gray)	Dec. 1–Oct. 15.
Quail (bobwhite), ruffed grouse (partridge), spruce hen (see exception)	Dec. 1–Oct. 15.
Exception: Upper Peninsula (ruffed grouse, spruce hen)	Dec. 1–Oct. 1
Pinnated grouse (prairie chicken), wild turkey, capercailzie, black game, hazel grouse, pheasants (English, Mongolian), wild pigeon	Until 1910.
European partridge	Until 1912.
Dove	All the year.
Snipe, plover, woodcock, duck, goose, brant, or other waterfowl (except that snipe, bluebill, canvasback, widgeon, redhead, pintail, whistler, spoonbill, butterball, and sawbill duck, goose, and brant may be hunted Mar. 2–Apr. 25, and goose and brant in Chippewa County at any time)	Jan. 2–Sept. 1.
Minnesota (1905–1907):	
Deer, male moose	Dec. 1–Nov. 10.
Elk, female moose, caribou, fawn	All the year.
Quail, partridge, ruffed grouse (pheasant)	Dec. 1–Oct. 1.
Sharp-tailed or white-breasted grouse, pinnated grouse or prairie chicken, turtle dove, woodcock, snipe, upland plover, golden plover	Nov. 1–Sept. 1.
Pheasants (Chinese, English, Mongolian, golden, Reeves, Japanese, tragopan, Temminck)	Until Jan. 1, 1910.
Duck, goose, brant, or any aquatic fowl	Dec. 1–Sept. 1.

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[a] On Grand Island, Alger County, native deer, mule deer, blacktail deer, elk, moose, caribou, lumbian), antelope, buffalo, native partridge, Manitoba grouse, dalripan (European ptarmigan), d ptarmigan are protected to June 7, 1910.

Close Seasons for Game—Continued.

	Close seasons.
Mississippi (1906):	
Deer (spotted fawn all the year), bear	Mar. 1–Nov. 15.
Quail or partridge	Mar. 1–Nov. 1.
Wild turkey (females all the year)	May 1–Jan. 1.
Dove	Mar. 1–Aug. 1.
Plover, tatler, chorook, grosbec, coot, rail (mud hen), duck, swan, goose, brant	Mar. 1–Sept. 1.
Missouri (1907):	
Deer	Jan. 1–Nov. 1.
Squirrels (gray, black, fox)	Jan. 1–June 1.
Quail (bobwhite, partridge)	Jan. 1–Nov. 1.
Ruffed grouse (pheasant), pinnated grouse (prairie chicken), Mongolian, Chinese, and English pheasants, and other imported game birds	Until Dec. 1, [illegible]
Wild turkey	Feb. 1–Dec. 1.
Dove, woodcock, plover	Jan. 1–Aug. 1.
Snipe, duck, goose	May 1–Sept. 15.
Montana (1905–1907):	
Deer	Dec. 15–Sept. 1.
Elk, antelope, mountain goat, mountain sheep	Dec. 1–Sept. 1.
Moose, caribou, bison or buffalo	All the year.
Quail, Chinese pheasant	All the year.
Grouse, prairie chicken, fool hen, pheasant, partridge, sage hen, turtledove, duck, goose, brant, swan	Dec. 1–Sept. 1.
Nebraska (1901–1907):	
Deer, antelope, elk, squirrel (gray, red, fox, timber)	All the year.
Quail	Dec. 1–Nov. 15.
Partridge, pheasant, ptarmigan, English partridge, Belgian partridge, English pheasant, Chinese pheasant, English black cock, other imported game birds, wild turkey, curlew	All the year.
Prairie chicken, sage chicken, grouse, dove, wild pigeon, plover	Dec. 1–Sept. 15.
Snipe, yellowlegs, crane, duck, goose, brant, or any game waterfowl	Apr. 11–Sept. 15.
Nevada[a] (1901–1903):	
Deer, antelope (males)	Nov. 15–Sept. 15.
Female deer and antelope, spotted fawn; all elk, caribou, mountain sheep, mountain goat	All the year.
Quail, grouse, prairie chicken, woodcock, snipe, plover, curlew, sandhill crane, duck	Mar. 1–Sept. 15.
Sage hen	Feb. 16–July 15.
Dove	Nov. 2–July 15.
Swan	All the year.
New Hampshire (1901–1907):	
Deer in Carroll and Coos counties	Dec. 1–Oct. 1
Deer in Grafton County	Dec. 15–Nov. 1
Deer in rest of State	Dec. 15–Dec. 1
Elk, moose, caribou	All the year.
Gray squirrel	Until Oct. 1, [illegible]
Hare, rabbit	Mar. 1–Oct. 1
Quail, partridge, ruffed grouse, woodcock, Wilson snipe	Dec. 1–Oct. 1
Dove	All the year
Killdeer, upland plover or Bartramian sandpiper, wood duck	Until Mar. [illegible]
Sandpiper, yellowlegs, plover, rail, duck (except sheldrake) ("beach birds," teal, coot, may be shot in Rockingham County July 15–Feb. 1)	Feb. 1–Oct. [illegible]
New Jersey (1903–1906):	
Deer,[b] 8 years	Until Nov. [illegible]
Squirrels (gray, black, fox), hare (rabbit)	Jan. 1–Nov. [illegible]
Quail (partridge), ruffed grouse (partridge or pheasant), prairie chicken, pheasant (English or ringneck pheasant),[c] wild turkey	Jan. 1–Nov. [illegible]
Dove	All the year.
Woodcock	Jan. 1–Oct. 1[d]

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[a] County commissioners may change dates of close seasons (without altering length [illegible] antelope, or sage hens, or lengthen close seasons, for any other game in their respective [illegible]

[b] Not applicable to deer in game preserves or to possession of imported deer properly tagged

[c] English or ringneck pheasants in established game preserves may be shot Oct. 1–Jan. 1 [illegible] owners of such preserves or such persons as they may designate.

[d] Except July.

Close Seasons for Game—Continued.

		Close seasons.
New Jersey (1903-1906)—Continued.		
English or Wilson snipe (bog or jack snipe)		Jan. 1-Sept. 1.[a]
Surf or bay snipe, sandpiper, yellowlegs, plover (except upland plover), curlew, all shore birds		Jan. 1-May 1.
Upland plover		Oct. 1-Aug. 1.
Reedbird, rail, marsh hen		Jan. 1-Sept. 1.
Duck, goose, brant, swan, or other wildfowl		May 1-Sept. 1.
New Mexico (1905-1907):		
Deer (with horns)		Dec. 1-Oct. 15.
Deer (without horns), elk, mountain sheep		All the year.
Antelope, 5 years		Until Mar. 13, 1910.
Quail (native or crested)		Feb. 1-Oct. 1.[b]
Mountain grouse, prairie chicken, wild turkey		Jan. 1-Oct. 1.
Bobwhite quail, pheasants, wild pigeon, 5 years		Until Mar. 13, 1910.
Ptarmigan		All the year.
Turtle dove		May 1-July 15.
New York (1900-1907) (*see special laws for Long Island on next page*):		
Deer (see exception)		Nov. 1-Sept. 16.
Exception: Orange and Sullivan counties	Nov. 16-Nov. 1	
Fawns, elk, moose, caribou, antelope		All the year.
Black bear (except in Essex and Lewis counties, unprotected)		July 1-Oct. 1.
Squirrel, black or gray (see exceptions)		Dec. 1-Sept. 16.
Exceptions: Chautauqua County	Dec. 1-Oct. 16	
Dutchess, Rensselaer, and Sullivan counties	Dec. 1-Oct. 1	
Greene County	Dec. 16-Oct. 1	
Orange County	Dec. 16-Oct. 16	
Richmond County (gray squirrel only)	All the year	
Saratoga County	Nov. 1-Sept. 16	
Hare, rabbit:		
Albany, Genesee, Monroe, Orleans, and Wyoming counties	Dec. 16-Sept. 16	
Broome and Cortland counties	Dec. 1-Sept. 16	
Dutchess County	Dec. 1-Oct. 16	
Erie, Madison, Rensselaer, Steuben, and Sullivan counties	Feb. 16-Oct. 1	
Fulton, Greene, and Schenectady counties	Feb. 1-Nov. 1	
Herkimer and Oneida counties	Feb. 15-Sept. 16	
Livingston and Ulster counties	Jan. 16-Oct. 1	
Orange County	Dec. 16-Oct. 16	
Richmond County	Dec. 16-Nov. 1	
Rockland County	Dec. 31-Nov. 1	
Westchester County	Dec. 1-Nov. 1	
Quail (see exceptions)		Dec. 1-Nov. 1.
Exceptions: Cattaraugus and Chautauqua counties	Dec. 1-Oct. 16	
Orange and Ulster counties	Dec. 16-Oct. 16	
Rensselaer County	Dec. 1-Oct. 1	
Richmond County, 2 years	Until 1908	
Grouse (see exceptions)		Dec. 1-Sept. 16.
Exceptions: Cattaraugus and Chautauqua counties	Dec. 1-Oct. 16	
Dutchess, Greene, Rensselaer, Sullivan, and Tioga counties	Dec. 1-Oct. 1	
Orange and Ulster counties	Dec. 16-Oct. 16	
Saratoga County	Nov. 1-Sept. 16	
Pheasants (Mongolian, ringneck, English), 6 years (see exception)		Until 1910.
Exception: Dutchess and Suffolk counties	Jan. 1-Nov. 1	
Dove		All the year.
Woodcock (see exceptions)		Dec. 1-Sept. 16.
Exceptions: Cattaraugus and Chautauqua counties	Dec. 1-Oct. 16	
Dutchess, Greene, Rensselaer, Sullivan, and Tioga counties	Dec. 1-Oct. 1	
Orange and Ulster counties	Dec. 16-Oct. 16	
Saratoga County	Nov. 1-Sept. 16	
Plover		Jan. 1-Aug. 16.
Wilson or English snipe, jacksnipe, bay snipe, yellowlegs, surf birds, curlew, rail, water chicken, mud hen, gallinule, shore birds, duck, goose, brant, swan.		Jan. 1-Sept. 16.

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[a] Except March and April.

[b] County commissioners on petition of 25 resident householders in any precinct may extend the pen season to April 1 in such precinct.

Close Seasons for Game—Continued.

	Close seasons.
Long Island (1900–1906):	
Deer shooting permitted only on first two Wednesdays and Fridays after first Tuesday of November (Nov. 6, 8, 13, and 15 in 1907).	
Squirrel (black or gray), hare, rabbit	Jan. 1–Nov. 1.
Quail (except on Robbins Island, protected all the year, and Gardiners Island, Feb. 1–Oct. 15), grouse	Jan. 1–Nov. 1.
Woodcock	Jan. 1–Aug. 1.
Pheasants (English, Mongolian, ringneck), in Suffolk County..Jan. 1–Nov. 1	
Dove	All the year.
Wilson or English snipe, jacksnipe, bay snipe, surf snipe, winter snipe, sandpiper, yellowlegs, willet, dowitcher, shortneck, plover, ringneck, killdeer, oxeye, curlew, rail	Jan. 1–July 15.
Gallinule, meadow hen, mud hen	Dec. 31–Aug. 15.
Duck, goose, swan	Jan. 1–Oct. 1.
Brant	May 1–Oct. 1.
North Carolina (1905) (*see county laws, pp. 51–52*):	
Deer	Feb. 1–Oct. 1
Quail, wild turkey, dove, lark, robin	Mar. 1–Nov. 1.
North Dakota (1901):	
Deer	Dec. 1–Nov. 10.
Elk, moose, caribou, buffalo, mountain sheep	All the year.
Antelope, 10 years	Until Jan. 1, 1911.
Quail, pheasants (English, Chinese), sharp-tailed grouse, ruffed grouse, pinnated grouse, prairie chicken, woodcock, swan	Oct. 15–Sept. 1.
Crane, duck, goose, brant	May 1–Sept. 1.
Ohio (1900–1904):	
Squirrel	Oct. 15–Sept. 1.
Rabbit	Dec. 5–Nov. 15.[a]
Raccoon	Mar. 1–Sept. 1.
Quail	Dec. 5–Nov. 15.
Ruffed grouse, introduced pheasants, 4 years	Until Nov. 15, [illegible]
Dove, woodcock	Dec. 1–Sept. 1.
Snipe, plover, shore birds, rail, coot or mud hen, duck, goose, swan	Dec. 1–Sept. 1.[b]
Oklahoma (1899):	
Deer, antelope	All the year.
Quail	Feb. 1–Oct. 15.
Grouse	All the year.
Prairie chicken, wild turkey	Jan. 1–Sept. 1.
Pheasants	Jan. 1–Dec. 1.
Dove, plover	Jan. 1–Aug. 1.
Oregon (1901–1907):	
Male deer (except in Baker, Coos, Curry, Grant, Harney, Malheur, Umatilla, Union and Wallowa counties)	Nov. 1–July 15.
Coos and Curry counties....Oct. 15–July 15	
Female deer (except in above counties)	Nov. 1–Sept. 1
Coos and Curry counties....All the year.	
Spotted fawn	All the year.
Elk	Oct. 15–Sept. 15.
Silver gray squirrel (*Sciurus fossor*)	Jan. 1–Oct. 1.
Partridge (English or gray), capercailzie, moor hen, pheasant (silver, golden, copper, green Japanese, and Reeves), wild turkey, woodcock	Dec. 1–Oct. 1
Prairie chicken (see exceptions)	Until Sept. 15, [illegible]
Exceptions: Wasco County....Oct. 15–Aug. 1	
Umatilla County....Dec. 1–Oct. 1	
Dove	All the year.
Upland plover, rail	Jan. 1–Aug. 1
Duck, goose,[c] swan (except in Lake County, Apr. 1–Aug. 15, and in Coos County, Feb. 1–Aug. 1)	Feb. 1–Sept. [illegible]

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[a] Applies to hunting with *gun* only.

[b] Except Mar. 1–Apr. 20; Sundays and Mondays are also closed seasons for ducks and other wa[illegible] fowl.

[c] Unlawful to kill geese at any time on islands or sand bars in the Columbia River east [illegible] Cascades.

Close Seasons for Game—Continued.

Oregon (1901-1907)—Continued.	*Close seasons.*
West of Cascades:	
Quail, bobwhite, partridge, grouse, native pheasant (ruffed grouse), ringneck (China torquatus) pheasant (see exceptions)	Dec. 1-Oct. 1.
Exceptions:	
Tillamook County: Native pheasant (ruffed grouse), ringneck (China torquatus) pheasant.....Dec. 1-Sept. 15	
Blue grouse.....Oct. 15-Aug. 1	
Clatsop, Coos, Curry, and Josephine counties: Ringneck (China torquatus) pheasant.....Dec. 1-Sept. 15	
Jackson County: Ringneck (China torquatus) pheasant...All the year	
East of Cascades:	
Quail (except in Wasco County, Oct. 15-Aug. 1, and Gilliam, Grant, Harney Umatilla, and Wheeler counties, to Jan. 1, 1912) hunting permitted only from second Saturday to third Tuesday in September (Sept. 14-17 in 1907) ..	
Native pheasant (ruffed grouse), grouse, sage hen	Dec. 1-Aug. 15.
Pheasant	All the year.
Mongolian ringneck (China torquatus) pheasant (see exception)	Until Feb. 15, 1910.
Exception: Gilliam, Grant, Harney, Umatilla, and Wheeler counties... To Jan. 1, 1912	
Pennsylvania (1905-1907):	
Deer (deer without horns protected all the year)	Dec. 1-Nov. 15.
Bear	Mar. 1-Oct. 1.
Squirrel	Dec. 1-Oct. 1.
Hare, rabbit	Dec. 1-Oct. 15.
Quail	Dec. 1-Nov. 1.
Ruffed grouse (pheasant), woodcock	Dec. 1-Oct. 1.
Prairie chicken, imported pheasants (Chinese, English, Mongolian), wild turkey	Dec. 1-Oct. 15.
Wild pigeon	Until Apr. 22, 1915
Dove, reedbird, rail, blackbird, sandpiper, tatler, curlew, or any shore bird...	Jan. 1-Sept. 1.
Wilson snipe (jacksnipe)	May 1-Sept. 1.
Upland or grass plover	Dec. 1-July 15.
Coot or mud hen	Jan. 1-Sept. 1.[a]
Wild waterfowl—duck, goose, brant, swan, grebe	Apr. 10-Sept. 1.
Rhode Island (1900-1907):	
Deer, 4 years	Until Jan. 1, 1908.[b]
Gray squirrel, hare, rabbit	Jan. 1-Nov. 1.
Quail or bobwhite, ruffed grouse or partridge, woodcock	Jan. 1-Nov. 1.
Pheasant, 5 years	Until Oct. 15, 1910.
Dove	All the year.
Black duck and wood duck	Apr. 1-Aug. 15.
outh Carolina (1902-1907):	
Deer (see exception)	Jan. 1-Sept. 1.
Exception: Beaufort, Berkeley, Charleston, Clarendon, Colleton, Darlington, Dorchester, Florence, Hampton, Horry, Kershaw, Marion, and Marlboro counties.....Feb. 1-Aug. 1	
Quail, partridge, pheasant, wild turkey, woodcock (see exception)	Mar. 1-Nov. 15.
Exception: Aiken, Barnwell, Beaufort, Berkeley, Charleston, Clarendon, Colleton, Dorchester, Fairfield, Georgetown, Hampton, Lexington, Oconee, and Saluda counties.....Apr. 1-Nov. 1	
Mongolian pheasant, 3 years	Until Jan. 1, 1910.
uth Dakota (1899-1905):	
Deer, elk, buffalo, mountain sheep	Dec. 1-Nov. 1.
Antelope, 10 years	Until Jan. 1, 1911.
Quail, ruffed grouse, sharp-tailed grouse, pinnated grouse, prairie chicken, woodcock	Jan. 1-Sept. 1.
Dove	All the year.
Plover, curlew	May 15-Sept. 1.
Crane, duck, goose, brant	May 1-Sept. 1.

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[a] Except Apr. 1-16.

[b] Tame deer kept in confinement may be killed by the owner at any time, or any deer injuring ps by any person on his premises under permit from secretary of state.

Close Seasons for Game—Continued.

	Close seasons.
Tennessee (1903–1907):	
Deer (except Fentress County, Jan. 1–Dec. 1)	Until Oct. 1, 1911.
Squirrel	Mar. 1–June 1.[a]
Quail or partridge	Mar. 1–Nov. 15
Grouse, pheasant (except English or ringneck pheasants), wild turkey,[b] meadowlark	Mar. 1–Nov. 1.
Pheasant, English or ringneck	Jan. 1–Dec. 1
Dove (see exception), teal, wood (summer) duck	Apr. 15–Aug. 1
Exception: Dove in Shelby County	Mar. 1–July 15
Robin, woodcock, snipe, sandpiper, plover, tatler, willet, godwit, curlew, avocet, marsh blackbird, rail, coot, mud hen, duck (except teal and wood duck), goose, brant, swan	Apr. 15–Oct. 1.
Texas (1907):	
Deer (female deer and spotted fawn protected all the year)	Jan. 1–Nov. 1.
Antelope, mountain sheep, 5 years	Until July 1, 1912
Quail or partridge, dove	Feb. 1–Nov. 1.
Prairie chicken or pinnated grouse, pheasants (Mongolian, English), 5 years	Until July 1, 1912
Wild turkey	Apr. 1–Nov. 1.[c]
Utah (1907):	
Deer with horns (see exception)	Nov. 1–Oct. 1
Exception: Nonresident not permitted to kill deer.	
Deer without horns, elk, antelope, sheep, any introduced game	Until Mar. 23,
Quail (see exceptions), pinnated grouse, pheasants (English, Mongolian, Chinese)	All the year.
Exceptions: Quail in Garfield, Kane, and Washington counties	Feb. 1–Aug. 1
Quail in Davis, Salt Lake, and Weber counties	Oct. 26–Oct. 14
Partridge, grouse, prairie chicken, sage hen, pheasant, mourning dove	Dec. 1–Aug. 1.
Snipe, shore birds, duck, goose, brant, swan	Jan. 1–Oct. 1.
Vermont (1894–1906):	
Deer	All the year exc. Oct. 21–27.[d]
Moose, caribou	All the year.
Gray squirrel	Dec. 1–Sept. 15
Hare, rabbit	May 1–Sept. 15
Quail, ruffed grouse or partridge, woodcock, English snipe, plover (other than upland)	Dec. 1–Sept. 15
Pheasant, English partridge	Until Oct. 1, 19
Dove	All the year.
Upland plover	Dec. 1–Aug. 1.
Duck, goose	Jan. 1–Sept. 1.
Virginia[e] (1903–1906):	
Deer	Jan. 1–Oct. 1
Squirrel:	
Alexandria County (gray)	Until Sept. 1, 1910
Isle of Wight and Southampton counties (gray or fox)	Jan. 15–Sept. 1
Rabbit:	
Accomac and Northampton counties	Jan. 15–Nov. 15
Alexandria, Fairfax, Fauquier, Loudoun, and Prince William counties.	Jan. 1–Nov. 1

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[a] *Special squirrel seasons:* Benton, Decatur, Wilson, Jan. 1–June 1; Carroll, Mar. 1–June 15; Ca Mar. 1–July 15; Crockett, Weakley, Feb. 1–July 1; Fayette, Jan. 1–July 15; Gibson Sevier, Feb. 1–J Hardeman, Feb. 15–July 15; Haywood, Jan. 1–May 1; Henderson, Jan. 15–July 15; Lauderdale, F July 1; McNairy, Madison, Mar. 1–July 1; Robertson, Jan. 1–July 1; Shelby, Feb. 1–June 15; Stew Feb. 1–Aug. 1; Warren, Mar. 1–Oct. 1. Bedford, Blount, Cannon, Clay, Coffee, Cumberland, D Fentress, Giles, Greene, Hickman, Humphreys, Jackson, Knox, Lawrence, Lincoln, London, Mar Maury, Meigs, Moore, Overton, Perry, Pickett, Putnam, Rhea, Sequatchie, Sullivan, Van B Washington, Wayne, White, Williamson, unprotected.

In Chester, Hardeman, Hardin, and McNairy counties anyone may kill squirrels on his own erty at any time for his own use.

[b] *Special wild turkey seasons:* Lauderdale, Jan. 1–Nov. 1; Dyer (gobblers), May 1–Nov. 1. Obe 1–Nov. 1; Clay, Fentress, Overton, Pickett, May 1–Aug. 1.

[c] *Vide* opinion of assistant attorney-general of Texas dated Sept. 17, 1907.

[d] Deer kept in private game preserves may be killed by the owners at any time.

[e] Boards of supervisors may shorten the open seasons in their counties and make other not repugnant to law "and may include in such protection other game not specifically this section." Code 1904, sec. 2070a as amended in 1906.

Close Seasons for Game—Continued.

Virginia (1903-1906)—Continued. *Close seasons.*

- Rabbit—Continued.
  - Amelia,[a] Charlotte,[a] Greenesville, Spottsylvania, and Sussex counties. Feb. 1-Oct. 1
  - Buckingham [a] and Cumberland [a] counties.................. Feb. 15-Oct. 15
  - Caroline, Essex, Hanover, Henrico, and King William counties. Feb. 1-Nov. 1
  - Chesterfield County.................. Feb. 1-Sept. 1
  - Culpeper and Orange counties.................. Jan. 15-Nov. 1
  - Elizabeth City County.................. Feb. 1-Nov. 15
  - Halifax County.................. Feb. 1-Oct. 15
  - James City and York counties, town of Williamsburg...... Feb. 15-Nov. 15
  - Nottoway County.................. Jan. 1-Sept. 1
  - Shenandoah County.................. Mar. 1-Nov. 1
  - Stafford County.................. Feb. 1-Sept. 15
- Opossum:
  - Halifax County.................. Feb. 1-Oct. 15
- Quail or partridge, pheasant or grouse, wild turkey, woodcock (see exceptions).................. Feb. 1-Nov. 1.
  - *Exceptions:* West of the Blue Ridge.................. Jan. 1-Nov. 1
    - Accomac and Northampton counties (pheasant, grouse—5 years). Until Mar. 14, 1909
- Pheasants (English, Mongolian), 5 years.................. Until Jan. 1, 1909.
- Dove.................. All the year.
- Robin.................. Mar. 1-Dec. 15.
- Snipe (except Wilson and robin snipe), sandpiper, plover (except black-breasted green-headed, and white), willet, tatler, rail (except sora), gallinule, mud hen.. Jan. 1-July 20.
- Summer or wood duck.................. Jan. 1-Aug. 1.
- Winter waterfowl.................. Apr. 1-Oct. 15.[b]

Washington [c] (1903-1907):

- Deer (see exception).................. Dec. 15-Sept. 15.
  - *Exceptions:* Deer on islands, except those containing game preserves. Nov. 1-Oct. 1.
    - Spotted fawn.................. All the year.
- Elk.................. Until Oct. 1, 1915.
- Moose, caribou, antelope, sheep, goat (males).................. Nov. 1-Sept. 15.
- Moose, caribou, antelope, sheep, goat (females).................. All the year.
- Quail west of Cascades.................. Jan. 1-Oct. 1
- Quail east of Cascades, 5 years.................. Until Sept. 15, 1908
- Bobwhite quail, Chinese or Mongolian pheasants in Okanogan County. Until Sept. 30, 1912.
- Partridge, grouse, prairie chicken, sage hen, native pheasant, ptarmigan (except east of Cascades, Nov. 15-Aug. 15; prairie chicken in Kittitas County, Oct. 1-Sept. 10).................. Jan. 1-Sept. 1.
- Pheasants (Chinese, Mongolian or other imported pheasant).................. Jan. 1-Oct. 1.
- Dove.................. All the year.
- Snipe, sand-hill crane, duck, swan (see exception).................. Mar. 1-Sept. 1.
  - *Exception:* Goose, brant, or other waterfowl on Columbia and Snake rivers, or within half a mile of their shores, in Columbia, Douglas, Franklin, Garfield, Klickitat, Kittitas, Wallawalla, Whitman, and Yakima counties.................. All the year.
- Goose, brant (except as above).................. May 1-Sept. 1.
- Plover, rail.................. Mar. 1-Aug. 15.

West Virginia (1903):

- Deer (except spotted fawn, protected all the year).................. Dec. 16-Oct. 15.
- Squirrel, rabbit.................. Jan. 1-Sept. 15.
- Quail or Virginia partridge.................. Dec. 20-Nov. 1.
- Ruffed grouse, pheasant, pinnated grouse or prairie chicken, wild turkey..... Dec. 15-Oct. 15.
- Dove.................. All the year.
- Woodcock.................. Nov. 2-July 15.
- Snipe.................. July 1-Mar. 1.
- Duck, goose, brant.................. Apr. 1-Oct. 1.

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[a] Young rabbits or hares may be killed or captured June 1-Aug. 1 in Amelia and Charlotte counties, and June 1-Oct. 15 in Buckingham and Cumberland counties.

[b] Wildfowl can not be hunted on Wednesdays and Saturdays on Back Bay, Princess Anne County

[c] On Mercer Island, Lake Washington, game animals and birds are protected all the year.

Close Seasons for Game—Continued.

		Close season.
Wisconsin (1898–1907):		
Deer (see exceptions)		Dec. 1–Nov. 11.
Exceptions: Door County, 5 years	Until Nov. 11, 1912	
Adams, Brown, Calumet, Columbia, Crawford, Dane, Dodge, Fond du Lac, Grant, Green, Green Lake, Iowa, Jefferson, Juneau, Kenosha, Kewaunee, La Crosse, Lafayette, Manitowoc, Marquette, Milwaukee, Monroe, Outagamie, Ozaukee, Racine, Richland, Rock, Sauk, Sheboygan, Vernon, Walworth, Washington, Waukesha, Waushara, and Winnebago counties	All the year	
Moose		All the year.
Squirrel (gray, black, fox), rabbit		Mar. 1–Sept. 1.
Quail, pheasants (Chinese, English, Mongolian), 8 years		Until Oct. 1, 191
Partridge, woodcock, snipe, plover		Dec. 1–Sept. 1.
Prairie chicken, grouse in Adams, Barron, Burnett, Buffalo, Chippewa, Clark, Crawford, Dodge, Dunn, Eau Claire, Grant, Iowa, Jackson, Juneau, Lafayette, Marquette, Monroe, Pepin, Polk, Portage, Richland, Rusk, Sawyer, St. Croix, Vernon, Washburn, Waushara, and Wood counties	Oct. 15–Oct. 1	
Prairie chicken, grouse in rest of State	Until Sept. 2, 1915	
Turtle dove, swan		All the year.
Rail or rice hen, duck, coot or mud hen		Jan. 1–Sept. 1.
Goose, brant		May 1–Sept. 1.
Wyoming (1903–1907):		
Deer, elk, antelope, mountain sheep		Nov. 15–Sept. 1
Moose, 9 years		Until Sept. 15, 19
Quail (bobwhite, California, Mexican), Mongolian pheasant, 5 years		Until Sept. 1, 19
Partridge, grouse, prairie chicken, sage chicken		Sept. 15–Aug. 1
Dove, swan		All the year.
Snipe, plover, green-shank, tatler, godwit, curlew, avocet, or other wader, duck, goose, brant		May 1–Sept. 1.
Alberta[a] (1906–7):		
Deer, moose, caribou		Dec. 1–Nov. 1.
Elk or wapiti		Until Nov. 1, 19
Antelope		Nov. 1–Oct. 1.
Buffalo		All the year.
Mountain sheep, mountain goat		Until Oct. 1, 19
Grouse, partridge, prairie chicken, ptarmigan, pheasant (except English)		Until Sept. 15, 19
English pheasant		All the year.
Crane, snipe, sandpiper, plover, curlew, shore bird, rail, coot		Jan. 1–Sept. 1.
Duck, goose, swan		Jan. 1–Aug. 22
British Columbia[b] (1898–1905):		
Deer (except fawns), sheep (except ewes and lambs), goat		Dec. 15–Sept. 1
Fawns, ewes, and lambs		All the year.
Bull elk or wapiti, bull moose, bull caribou, hare		Jan. 1–Sept.
Females and young of elk, moose, and caribou		All the year.
Quail, English partridge, pheasant, swan, and all imported game birds		All the year
Grouse, prairie chicken, ptarmigan (see exception)		Jan. 1–Sept. 1
Exception: Grouse and ptarmigan north of latitude 55°	Apr. 1–Sept. 15	
Snipe, plover, duck (see exception)		Mar. 1–Sept. 1
Exception: Duck, north of latitude 55°	Apr. 1–Sept. 15	

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[a] Except for elk and buffalo the seasons here given do not apply to that portion of the [illegible] north of latitude 55°.

[b] The lieutenant-governor is empowered to make further restrictions in these seasons. [illegible] Indians (nonresidents not allowed to hunt) and farmers in "unorganized districts" may kill [illegible] immediate use as food, but Indians can kill does and fawns only Aug. 1–Feb. 1; free mi[illegible] engaged in placer mining or prospecting in unorganized districts, and surveying or eng[illegible] parties engaged in their duties may kill any game for food. By proclamation of March 31, 1[illegible] lieutenant-governor in council declared that "all that portion of the Province not included [illegible] any municipality, except the Kamloops, Okanagan, Similkameen, Greenwood, and Grand [illegible] Electoral Districts, shall be defined as an unorganized district within the meaning of the [illegible] Protection Act, 1898.'" The following special seasons have been made by orders in council: [illegible] municipalities of Chilliwack and Kent (Agassiz) no birds may be shot before October 15, 19[illegible] [illegible] Okanagan electoral district prairie chickens, willow grouse, and blue grouse are protected unt[illegible] tember 1, 1910; and in the Lillooet and Cariboo electoral districts the open season for mountain [illegible] closes November 14 in each year.

Close Seasons for Game—Continued.

Manitoba (1902–1907):	*Close seasons.*
Deer, elk or wapiti, moose, caribou or reindeer, antelope or cabri (males)	Dec. 15–Dec. 1.
Females and young of foregoing species and bison or buffalo	All the year.
Quail, woodcock, snipe, sandpiper, plover (except upland plover)	Jan. 1–Aug. 1.
Grouse, partridge, prairie chicken	Nov. 1–Oct. 1.
Dove	All the year.
Pheasant, 5 years	Until Oct. 1, 1909.
Upland plover	Jan. 1–July 1.
Duck	Dec. 1–Sept. 1.
New Brunswick (1899–1905):	
Deer, moose, caribou (cow and calf moose and cow caribou all the year)	Dec. 1–Sept. 15.
Partridge	Dec. 1–Sept. 16.
Pheasant	All the year.
Woodcock, snipe, teal, wood duck, dusky or black duck, goose, brant	Dec. 2–Sept. 1.
Shore or other birds on beaches, islands, or lagoons bordering tidal waters of Northumberland Strait, Gulf of St. Lawrence, and Bay of Chaleur	Jan. 1–Sept. 1.
Newfoundland [a] (1902–1906):	
Elk, moose, 10 years	Until Jan. 1, 1912.
Caribou (except in a special region near Grand Lake, all the year)	Feb. 1–Oct. 21.[b]
Ptarmigan, willow grouse or partridge, any grouse	Jan. 12–Oct. 1.
Snipe, plover, curlew, or "other wild or migratory birds (except wild geese)".	Jan. 12–Aug. 21.
Nova Scotia (1900–1907):	
Deer, caribou, 5 years	Until Oct. 1, 1910.
Moose (see exception)	Dec. 1–Oct. 1.
Exception: Cape Breton Island until Oct. 1, 1915. Calf moose under 1 year	All the year
Hare, rabbit	Mar. 1–Nov. 1.
Ruffed grouse or partridge (see exception)	Nov. 1–Oct. 1.
Exception: Cape Breton Island ruffed grouse and spruce partridge, 4 years.	Until Oct. 1, 1911
Spruce partridge [see exception above), sharp-tailed grouse, ptarmigan, blackcock, capercailzie, chukar partridge, pheasant, woodcock, snipe, curlew, plover, teal, blue-winged duck (see exception) wood duck	Mar. 1–Sept. 1.
Exception: Cumberland Co. (blue-winged duck)	May 1–Sept. 1
Ontario [c] (1907):	
Deer (young protected all the year)	Nov. 16–Nov. 1.[d]
Elk or wapiti	All the year.
Moose, caribou, or reindeer (see exception)	Nov. 16–Oct. 16.[e]
Exception: Female moose and young moose and caribou	All the year.
Squirrel (black or gray)	Dec. 2–Nov. 1.
Hare [f]	Jan. 1–Oct. 1.
Quail, wild turkey	Dec. 2–Nov. 1.
Grouse, pheasants, prairie fowl, partridge, woodcock	Dec. 16–Sept. 15.
Capercailzie	Until Sept. 15, 1909.
Snipe, plover, rail, other shore birds or "waders"	Dec. 16–Sept. 1.
Dove	All the year.[g]
Goose, swan	May 1–Sept. 15.
Duck and other waterfowl (except goose and swan)	Jan. 1–Sept. 1.
Prince Edward Island (1906–1907):	
Hare, rabbit	Mar. 1–Sept. 1.
Partridge	Until Oct. 1, 1906.
Wild turkey, plover, curlew	Jan. 1–July 15.

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[a] Stipendiary magistrates may in their respective districts prohibit destruction of hares and rabbits for specified terms.

[b] Except Aug. 1–Oct. 1.

[c] Lieutenant-governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River, and in the vicinity of Rondeau Park, and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

[d] Persons who put or breed deer on their own lands, and their licensees, may hunt such deer Oct. 1–Nov. 16.

[e] South of the Canadian Pacific R. R., between Mattawa and the Manitoba boundary, Nov. 16–Nov. 1

[f] Cottontail rabbits (wood hares) may be killed during close season when damaging trees or shrubs.

[g] Under act for protection of insectivorous birds, Rev. Stats. 1897, ch. 289, sec. 3.

Close seasons for Game—Continued.

	Close seasons.
Prince Edward Island (1906-1907)—Continued.	
Woodcock, snipe	Jan. 1-Sept. 1.
Yellowlegs, shore and other birds along beaches or tidal marshes, teal, black, or bluewinged duck	Jan. 1-Aug. 20.
Goose	May 10-Sept. 15.
Brant	June 10-Oct. 1.
Quebec (1899-1906):	
Zone 1. [a] Deer, moose (see exceptions)	Jan. 1-Sept. 1.
Exceptions: In Ottawa and Pontiac counties	Dec. 1-Oct. 1
Cow moose and young deer and moose	All the year
Caribou (young protected all the year)	Feb. 1-Sept. 1.
Hare	Feb. 1-Dec. 1.
Bear	July 1-Aug. 20.
Birch or swamp partridge	Dec. 15-Sept. 1.
White partridge or ptarmigan	Feb. 1-Nov. 1.
Woodcock, snipe, sandpiper, plover, tatler, curlew	Feb. 1-Sept. 1.
Widgeon, teal, duck, sheldrake	Mar. 1-Sept. 1.[b]
Zone 2. Close seasons same as in Zone 1, except as follows:	
Caribou	Mar. 1-Sept. 1.
Hare	Mar. 1-Oct. 15.
Birch or swamp partridge	Feb. 1-Sept. 15.
White partridge or ptarmigan	Mar. 1-Nov. 15.
Saskatchewan [c] (1905-7):	
Deer, elk or wapiti, moose, caribou (females and young all the year)	Dec. 15-Dec. 1.
Antelope (young all the year)	Nov. 15-Oct. 1.
Buffalo	All the year.
Grouse, partridge, prairie chicken, ptarmigan	Dec. 1-Sept. 15.
English pheasant	All the year.
Crane	Jan. 1-Aug. 1.
Snipe, sandpiper, plover, curlew, shore birds, rail, coot, duck, goose, swan	Jan. 1-Sept. 1.
Unorganized Territories[d] (Keewatin, etc.), 1894:	
Deer, elk or wapiti, moose, caribou, mountain sheep, mountain goat	Apr. 1-Dec. 1.[e]
Musk ox	Mar. 20-Oct. 15.
Grouse, partridge, prairie chicken, pheasant	Jan. 1-Sept. 1.
Duck, goose, swan	Jan. 15-Sept. 1.
Yukon[f] (1901):	
Deer, elk or wapiti, moose, caribou, mountain sheep, mountain goat, musk ox.	Jan. 1-Oct. 1.
Bison or buffalo	All the year.
Grouse, partridge, prairie chicken, ptarmigan, pheasant	Jan. 15-Oct. 1.
Snipe, sandpiper, crane, duck, goose, swan	June 1-Sept. 1.

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[a] Zone No. 1 comprises the whole Province, except that part of the counties of Chicoutimi and Saguenay east and north of the river Saguenay. Zone No. 2 comprises the excepted part of said counties.

[b] Inhabitants of Zone 2 and Gaspé County may take these birds for food at any season except June 1-Aug. 1.

[c] Lieutenant-governor-in-council may extend close seasons over current year within limits on petition of 6 game guardians.

[d] Indians, inhabitants, and travelers, explorers, and surveyors in need of food exempt. Governor in-council may alter seasons.

[e] Except July 15-Oct. 1.

[f] Indians, explorers, surveyors, prospectors, miners, and travelers in need of food are exempt. Commissioner-in-council may alter seasons.

SHIPMENT OF GAME.

Shipment is the most important feature of the traffic in game. It has, likewise, a marked effect upon the perpetuation of game, and when permitted without limitation is a great factor in its rapid destruction. A realization of this fact has induced many of the States to prohibit export of all or certain kinds of game and in a few instances all transportation even within the State. The subject may be conveniently considered under the following subheads: "Federal laws," "Marking packages," and "State laws prohibiting export."

FEDERAL LAWS.

Federal laws for the protection of game comprise the statutes regulating interstate commerce in game and the importation of birds from foreign countries and those providing for the protection of birds and game on territory under the immediate jurisdiction of the United States.

They comprise: (1) The Lacey Act, regulating the importation of game and its shipment from one State to another; (2) the tariff act, imposing duties on game, skins, and feathers imported from foreign countries; (3) the act regulating the introduction of eggs of game birds; (4) game laws of the District of Columbia, Alaska, and the Indian Territory, and (5) provisions for protecting birds in the National parks,[a] National forests, and other Government reservations. These laws are more fully discussed in Bulletin No. 16 of the Biological Survey, entitled "Digest of Game Laws for 1901" (pp. 69–79). The full text of several may be found in various circulars published by the Biological Survey: Circular No. 29 (1900) contains the Lacey act, Circular No. 34 (1901), the game laws of the District of Columbia, and Circular No. 42 (1904), the Alaska game law, with regulations for 1904, which are still in force.

MARKING PACKAGES.

Section 4 of the Lacey Act requires every package containing game animals or birds when shipped by interstate commerce to be clearly marked so as to show the name and address of the shipper and the nature of the contents. The laws of Colorado, Connecticut, Louisiana, Michigan, Mississippi, Montana, Nebraska, North Carolina, Ohio, Oregon, South Carolina, Wisconsin, New Brunswick, and Ontario likewise require each package of fish or game to bear a statement indicating the contents. Such general statements as "game" or "birds" are not sufficient to show the nature of the contents; the *kind* of game should be shown, and also the *amount* in the package.

Some of the State laws are very explicit on the subject of marking. Nebraska requires all packages to be labeled with the address of the consignor and the amount of each kind of game contained in the package, and provides a fine of $10 to $50 for omission of these details. Ohio and North Carolina have similar requirements. Michigan requires all packages of game to be plainly marked on the outside with the names of the consignor and consignee, the initial point of billing and destination, and an itemized statement of the quantity of game contained therein. South Carolina requires the names of consignor, consignee, and owner, and a description of the contents. Wisconsin's requirements are similar, and heavy penalties are provided for violation. Mississippi directs that the package bear the names of consignor and consignee and an itemized statement of the species of game, and further provides that the contents must be packed so as to be readily seen. In Louisiana and Ontario packages must also be made so as to show the contents, besides bearing, on the outside, a description of the contents and the names and addresses of owners. Several States require big game and game birds carried by sportsmen to be marked with the owner's name, shipped as baggage, and transported open to view.

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[a] The law governing the Yellowstone Park prohibits any person, or any stage, express, or railway company from receiving for transportation animals, birds, or fish taken in the park, under a penalty not exceeding $300. (28 Stat. L., ch. 72, sec. 4.)

Railroad and express companies should call the attention of their agents to these provisions, and insist that all packages be properly marked before shipment. In Nebraska, South Carolina, and Wisconsin common carriers are prohibited, under heavy penalties, from receiving consignments of game not properly labeled. In Texas they may examine suspected packages, and in Arkansas they may cause them to be opened when necessary, and may refuse packages supposed to contain fish or game for export. In Michigan and Wisconsin packages of fish or game may be broken open by game wardens, and if not properly marked may be confiscated.

STATE LAWS PROHIBITING EXPORT.

Since the constitutionality of the Connecticut statute prohibiting export of certain game was established by the Supreme Court in 1896[a] nonexport laws have been generally adopted, and at the present time every State prohibits the export of certain kinds of game. (See fig. 1, p. 33.) In some States sportsmen are allowed to carry a limited amount of game out of the State under special restrictions, and exceptions to the laws prohibiting export are also made in the case of birds and animals intended for propagation.

Restrictions on shipment from the State have now become so stringent that all the States and Territories west of the Mississippi River except two prohibit export of all game protected by local laws. Of the two exceptions, Iowa prohibits export of all game but shore birds and Wyoming export of certain species. East of the Mississippi similar laws are in force in nearly all of the States north of the Ohio and Potomac rivers, and also in Alabama, Mississippi, Tennessee, Virginia, and West Virginia. The export of most if not all protected game taken within the State is prohibited in all these States except Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, Maryland, and Illinois, and in these export of certain kinds of game is illegal.

Deer can be lawfully exported from only six States—Delaware (where they do not occur), Georgia, Kansas, Kentucky, North Carolina, and Ohio. The export of deer hides is prohibited by special provisions in the laws of Alaska, California, Florida, Wyoming, British Columbia, and Ontario; Wisconsin limits the export of green hides to the period from November 13 to December 3 of each year; Washington and British Columbia prohibit killing deer for hides; Oregon makes all hunting for hides dependent on permission of the State game and forestry warden; and New Brunswick and Newfoundland allow shipment of green hides only under license.

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[a] Geer v. Connecticut, 161 U. S., 519.

Among game birds the most general prohibition is that of the export of quail, which is now in force in every State and Territory, with two exceptions. In one of the excepted States, Wyoming, quail do not occur; in the other, Maryland, several counties prohibit their export. A number of States permit imported birds to be exported, however, and Colorado, Illinois, and Montana allow quail to be shipped from the State under permit. Besides these exceptions, 23 States, including Oregon (see table), permit nonresident hunters to take a limited number of birds out of the State; Maine, Montana, South Dakota, Vermont, Virginia, Wyoming, British Columbia, and New Brunswick grant the same privilege to resident hunters.

Special attention is called to the following table, which contains a list of the game prohibited from export by each State and Territory:

Export of Game Prohibited.

Alabama:

Deer, squirrel, quail or partridge, ruffed grouse or pheasant, imported pheasant or other imported game bird, wild turkey, dove, rail coot or mud hen, woodcock, snipe, sandpiper, curlew, shore birds, duck, goose, brant, swan.

Exceptions: Nonresident licensee may take with him or have carried to him, openly, game lawfully killed by him. State game and fish commissioner may issue permit to any person to capture, kill, or export game birds at any time, dead or alive, for scientific or propagating purposes; fee $1.

Alaska:

Deer, moose caribou, mountain sheep, mountain goat, wild birds or any parts thereof.

Exception: Specimens and trophies may be exported under restrictions imposed by the Secretary of Agriculture.[a]

Arizona:

Deer, elk, antelope, sheep, goat, quail, bobwhite, partridge, grouse, pheasant, wild turkey, snipe, rail, duck, goose, brant.

Arkansas:

All game except rabbits, which must be shipped open to view.

California:

Deer, deerskins, quail, partridge, grouse, prairie chicken, sage hen, pheasant, dove, wild pigeon, shore birds, plover, snipe, rail, curlew, ibis, duck.

Colorado:

Deer, elk, antelope, bison, buffalo, sheep, quail, partridge, grouse, ptarmigan, prairie chicken, sage chicken, pheasant, wild turkey, dove, pigeon, snipe, curlew, crane, duck, goose, brant, swan, waterfowl.

Exception: Game may be exported under permit from game commissioner if permit be attached and package plainly marked so as to show nature of contents. The following fees are charged for export permits: Elk, $10; deer, $5; antelope, $5.

Connecticut:

Quail, ruffed grouse, woodcock.

Delaware:

Rabbit, quail, partridge, woodcock (nonresidents also prohibited from shipping English snipe).

Florida:

Deer, deer hides, quail or partridge, wild turkey from county.

Georgia:

Quail or partridge.

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[a] See Circular No. 42, Biological Survey, U. S. Department of Agriculture, 1904.

Export of Game Prohibited—Continued.

Idaho:

Deer, elk, moose, caribou, antelope, buffalo, mountain sheep, mountain goat, quail, partridge grouse, prairie chicken, sage hen, Mongolian pheasant, dove, plover, snipe, duck, goose, swan.

Exception: Any hunter may export, under hunting license, animals lawfully taken; but each shipment must be accompanied by a sworn statement of number and date of license and fact that game was not procured contrary to law.

Illinois:

Squirrel, quail, ruffed grouse, pinnated grouse, prairie chicken, pheasant, wild turkey, duck, goose, brant, taken in the State.

Exception: Game may be exported under license from the State; nonresident may take from State 50 birds killed by himself, if carried openly for inspection.

Indiana:

Deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, and other waterfowl.

Exception: Nonresident may take from State 15 birds killed by himself, if carried openly for inspection, together with his license, or 45 if he has hunted for 3 or more days consecutively.

Indian Territory:

"Every person other than an Indian who hunts, traps, takes, or destroys any game *except for subsistence in the Indian country*, shall forfeit all traps, guns, and ammunition in his possession, and shall be liable in addition to a penalty of $500." (Rev. Stat. U. S., 1878, sec. 2137.)

Iowa:

Squirrel, quail, ruffed grouse, pinnated grouse, prairie chicken, pheasant, wild turkey, woodcock duck, goose, brant.

Exception: Nonresident may take from State not more than 25 game birds or animals killed by himself, if carried openly for inspection.

Kansas:

Quail, partridge, grouse, prairie chicken, pheasant, dove, plover, duck, goose, brant.

Kentucky:

Quail, partridge, grouse, pheasant, wild turkey, killed in the State.

Louisiana:

Deer, squirrel, quail, prairie chicken, wild turkey, dove, grosbec, woodcock, snipe, surf bird, chorook, sandpiper, plover, tatler, curlew, papabotte (upland plover), rail (mud hen), gallinule, coot (poule d'eau), duck, goose, brant, swan, taken in the State.

Exception: A sportsman may carry with him out of the State 1 deer and 12 birds of each kind.

Maine:

Deer, moose, quail, ruffed grouse, pheasant, capercailzie, black game, plover, woodcock, snipe, sandpiper, wood duck, dusky or black duck, teal, gadwall or gray duck, mallard, widgeon, baldpate, shoveler, pintail or sprigtail, redhead, scaup or greater bluebill, lesser scaup or lesser bluebill, golden-eye or whistler, buffle head, ruddy duck or broadbill.

Exceptions: A resident of the State may export 1 deer in a season if open to view, tagged to show name and address of owner and accompanied by him, and under shipping license 1 moose, 6 partridges, 10 woodcock, and 10 ducks lawfully killed by himself. A nonresident may export under hunting license 1 moose and 2 deer lawfully killed by himself; and may take home 10 partridges, 10 ducks, and 10 woodcock. Any person may export a pair of game birds under a special 50-cent license.

Maryland: *County provisions, as follows:*

Allegany—Quail, pheasant, wild turkey, woodcock.

Anne Arundel—Squirrel, rabbit, quail, partridge, pheasant, woodcock, snipe, plover from county.

Baltimore—Partridge, pheasant, woodcock

Calvert—Rabbit, partridge, woodcock from county (for sale, barter, or trade).

Caroline—Rabbit, quail, partridge, woodcock from county.

Dorchester—Squirrel, rabbit, quail, partridge, woodcock, dove.

Exception: Twelve quail or partridges, 6 squirrels, rabbits, woodcock, and doves may be taken out of the county as personal baggage, if carried openly and not intended for sale.

Frederick—Squirrel, partridge, pheasant, woodcock from county.

Kent—Squirrel, rabbit, and all birds from county (for sale, except under license).

Montgomery—Partridge, pheasant, wild turkey from county (for sale).

Queen Anne—Rabbit, partridge, woodcock from county (for sale).

Somerset—Squirrel, rabbit, quail or partridge, pheasant, dove, woodcock, duck, goose from county.

Washington—Deer, squirrel, rabbit, partridge, pheasant, wild turkey from county (for sale).

Wicomico and Worcester—Quail or partridge from both counties considered as one territory.

Massachusetts:

Quail, ruffed grouse, woodcock taken in the State; other game illegally taken in the State.

Exception: Nonresident may take 6 birds out of the State under his hunting license.

Export of Game Prohibited—Continued.

Michigan:

Deer, elk, moose, caribou, squirrel, quail, partridge, ruffed grouse, prairie chicken, spruce hen, Manitoba grouse, ptarmigan, Mongolian or English pheasant, wild turkey, dove, pigeon, snipe, plover, woodcock, duck, goose, brant, and other wild waterfowl.

Exceptions: (1) Game consigned to a point within the State may be transported outside the State if necessary to reach destination.

(2) Nonresident licensee may take out 1 deer under permit from State warden.

(3) Landowners and members of clubs owning game preserves may ship during open season under a $10 permit from State warden 50 ducks or other migratory birds lawfully killed by them on their own premises.

Minnesota:

Deer, elk, moose, caribou, hide or horns thereof, quail, partridge, ruffed grouse, prairie chicken, pinnated grouse, sharp-tailed or white-breasted grouse, ringneck or English pheasant, dove, snipe, duck, goose, brant, or any aquatic fowl.

Exception: Nonresident licensee may ship in open season, under his license coupons, to his residence, 1 deer and 25 birds lawfully taken by himself.

Mississippi:

Deer, bear, quail or partridge, wild turkey, dove, plover, tatler, chorook, grosbec, coot (poule d'eau), rail (mud hen), duck, goose, swan, brant.

Missouri:

Deer, squirrel, quail, pinnated grouse, prairie chicken, ruffed grouse, pheasant, wild turkey, dove, woodcock, snipe, plover, duck, goose from county:

Exceptions: Any person may take 1 deer, 2 wild turkeys, 25 quail, and 25 ducks, lawfully killed by him, to his residence by the usual manner of travel. Deer or elk from private preserves may be exported dead or alive under a special 50-cent permit from the county game warden.

Montana:

Deer, elk, moose, buffalo, mountain sheep, mountain goat, quail, pheasant or partridge, prairie chicken, fool hen, sage hen, grouse, Chinese pheasant, duck, goose, brant, swan.

Exception: Game lawfully killed may be exported during the open season if accompanied by the owner, and when shipped by resident of State, by permit from State game and fish warden, or when shipped by nonresident of State, by hunting license; total shipment under one license not to exceed number allowed to be killed in one season; all packages to be plainly labeled to show nature of contents.

Nebraska:

Deer, elk, antelope, quail, partridge, pheasant, grouse, ptarmigan, prairie chicken, sage chicken, wild turkey, pigeon, dove, snipe, plover, yellowlegs, curlew, crane, duck, goose, brant, swan.

Exception: Nonresident may ship 50 birds out of State under hunting license, but must give common carrier invoice of number and kind of birds, must have details of shipment marked on license, and must accompany the shipment.

Nevada:

Deer, elk, antelope, caribou, mountain sheep, mountain goat, quail, grouse, pheasant, sage chicken, prairie chicken, dove, snipe, plover, woodcock, curlew, sandhill crane, duck, goose.

New Hampshire:[a]

Elk, moose, caribou, quail, partridge, ruffed grouse, pheasant, woodcock, Wilson snipe, dove, plover, yellowlegs, sandpiper, rail, duck (except sheldrake), and all "beach" birds.

Exception: Nonresident may export, under his hunting license, 2 deer and 12 birds, carried open to view, on notice of number and kind to the commissioner who issued the license.

New Jersey:

Hare, rabbit, squirrel, quail or partridge, ruffed grouse or pheasant, pinnated grouse, English pheasant, ringneck pheasant, woodcock.

Exception: English or ringneck pheasants killed on preserves established prior to April 15, 1908, may be exported from the State.

New Mexico:

Deer, elk, antelope, mountain sheep, native or crested quail, bobwhite quail, partridge, mountain grouse, prairie chicken, pheasant, ptarmigan, wild turkey, turtle dove, wild pigeon for market.

New York:

Game or birds taken in the State, including deer (excepting head, feet, and skin), elk, antelope, moose, caribou, squirrel, hare, rabbit, quail, grouse, Mongolian and English pheasants, plover, Wilson or English snipe, woodcock, curlew, shore birds, rail, mud hen, gallinule, water chicken, duck, goose, brant, or swan.

Blue Mountain Forest Association permitted to ship deer, elk, and moose killed in its preserve.

Export of Game Prohibited—Continued.

North Carolina:[a]

Quail, partridge, pheasant, grouse, wild turkey, snipe, shore or beach bird, woodcock, tak State.

Exception: Nonresident may take out of State under his hunting license 50 quail (partridg 12 grouse, 2 turkeys, and 50 beach birds or snipe in a season.

North Dakota:

Deer, elk, moose, caribou, antelope, buffalo, mountain sheep, quail, ruffed grouse, prairie chick pinnated grouse, sharp-tailed grouse, English or Chinese pheasant, woodcock, crane, d goose, brant, swan.

Ohio:

Squirrel, quail, ruffed grouse or pheasant, Mongolian pheasant, English or ringneck pheas dove, woodcock, plover, snipe, shore birds, rail, duck, goose, swan, coot, mud hen.

Exception: Nonresident may take with him from State under his hunting license 50 anim and birds.

Oklahoma:

Deer, antelope, quail, grouse, prairie chicken, imported pheasant, wild turkey, dove, plover.

Oregon:

Deer, antelope, elk, moose, mountain sheep (or hides of said animals), quail or bobwhite, Eng lish or gray partridge, capercailzie, moor hen, grouse, sage hen, pheasant; Mongolian, silve golden, copper, green Japanese, and Reeves pheasants; prairie chicken, wild turkey, woodc rail, upland plover, duck, goose, swan, or other wildfowl.

Exception: Any citizen of Washington may take one day's bag with him out of the Sta

Pennsylvania:

Deer, rabbit, hare, squirrel, quail, partridge, grouse, pheasant; English, Mongolian, or Chi pheasant; wild turkey, reedbird, plover, woodcock, rail, web-footed wildfowl, taken in St

Rhode Island:

Quail, ruffed grouse, woodcock.

South Carolina:

Deer, quail, partridge, grouse, pheasant, wild turkey, woodcock, snipe, and other game bi animals.

Exception: Licensee may carry openly in his hand 2 deer, 50 partridges, 12 ruffed gr 4 wild turkeys, 50 beach birds, 50 wild ducks and geese in a season.

South Dakota:

Deer, elk, antelope, buffalo, mountain sheep, quail, ruffed grouse, prairie chicken, pinnate grouse, sharp-tailed grouse, plover, curlew, woodcock, crane, duck, goose, brant.

Exception: Two deer, 1 elk, 1 buffalo, 1 mountain sheep, and not more than 15 bir intended for commercial purposes may be shipped in open view during open season a days thereafter, when tagged and accompanied by owner; and in the case of big ga certificate—good for 5 days—that such game was lawfully killed must be obtained f justice of the peace and given to the carrier.

Tennessee:

All State game, viz: Deer, squirrel, quail, partridge, grouse, prairie chicken, pheasant turkey, marsh blackbird, dove, meadowlark, robin, plover, snipe, woodcock, sandpiper, w willet, curlew, godwit, avocet, rail, coot, mud hen, duck, goose, swan, brant.

Exception: Nonresident may take with him from the State 50 ducks or 30 head of game, but must present to some officer or employee of common carrier his hunting l and sworn statement that his game is not for sale and will not be sold.

Texas:

All wild animals, wild birds, and wild fowl found in the State, including deer, antelope, m tain sheep, quail or partridge, grouse, pinnated grouse or prairie chicken, Mongol English pheasant, wild turkey, dove, pigeon, plover, snipe, jacksnipe, curlew, duck, goo

Exception: Nonresident licensee may take one day's bag out of State.

Utah:

Deer, elk, antelope, mountain sheep, quail, partridge, prairie chicken, sage hen or grou nated grouse, pheasant, Mongolian, Chinese, or English pheasant, dove, snipe, shore bird goose, brant, swan, or any introduced game animal or bird.

Vermont:

Deer, gray squirrel, quail, ruffed grouse or partridge, plover, English snipe, woodcock, duck

Exception: One deer may be exported during the open season and ten days thereaft resident, if shipped open to view, properly labeled with the name of the owner and panied by him; and by a nonresident when his license, with shipping coupons atta presented to the transportation company.

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[a] The following county laws are also in force: Brunswick, Dare, New Hanover—Wild fow 10-November 10 from county. Catawba, Iredell, Surry, Swain—Quail from county.

Export of Game Prohibited—Continued.

Virginia:

Deer, venison, quail or partridge, pheasant or grouse, wild turkey, woodcock, plover, snipe, sandpiper, surf-bird, curlew, willet, tatler, rail (except sora), mud hen, gallinule, waterfowl.

Exceptions: During open season nonresident may, under his hunting license, take with him out of the State, or as baggage on the same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, 30 waterfowl, and 25 of each, or 100 in all, of plover, snipe, sandpipers, willets, tatlers, and curlew, if killed or captured by himself, and shipped open to view and plainly labeled with his name and address. Any citizen of State may ship from the State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, and 12 waterfowl, if open to view and plainly labeled with names and addresses of donor and donee, and number of each kind of bird so shipped.

Washington:

Deer, elk, moose, caribou, antelope, mountain sheep or goat, quail, partridge, grouse, prairie chicken, sage hen, pheasant, ptarmigan, plover, rail, sandhill crane, snipe, duck, goose, brant, swan or any other game animal or bird of the State, including introduced bobwhite, California valley quail, mountain quail, and Old World pheasants.

Exception: Nonresident may export one season's limit of big game and one day's bag limit of birds under his hunting license, if accompanied by affidavit that the game was killed by him and is not for sale.

West Virginia:

Deer, quail, pheasant, ruffed grouse, wild turkey.

Wisconsin:

Deer, quail, partridge, grouse, prairie chicken, pheasant, Mongolian, Chinese, or English pheasant, dove, plover, snipe, woodcock, rail, wild duck, goose, brant, swan, or other aquatic fowl.

Exception: During open season nonresident may take out of State under his hunting license, in personal possession or as baggage or express, accompanying same to State line, 1 deer and not more than 30 game animals and birds of all kinds, provided packages are plainly marked so as to show the names and addresses of shipper and consignee and number of each kind of game, and, in case of deer, have proper coupons attached.

Wyoming:

Deer, elk, moose, antelope, mountain sheep, or green hides, teeth, or horns of any of said animals.

Exceptions: Smithsonian Institution or other well-known scientific institutions may export any game animals or birds, under permit of State game warden; mounted heads and stuffed specimens may be shipped out of State.

Export of 1 hide, 1 scalp, 1 head, and 1 pair of tusks of any big game except moose, permitted upon affidavit that they were taken from animals lawfully killed and the payment of 25 cents to the justice of the peace of precinct where affiant lives and attachment of the tag issued by him; and a nonresident (or resident, when necessary to cross territory of another State to reach his home) may export under his hunting license carcasses, heads, antlers, scalps, skins, and teeth of any animals lawfully killed.

Alberta:

Deer, elk, moose, caribou, buffalo, sheep, goat, antelope, grouse, prairie chicken, pheasant, ptarmigan, snipe, sandpiper, plover, curlew, shore bird, rail coot, crane, duck, goose, swan.

Exceptions: Commissioner of Agriculture may grant permits to export for propagation for public parks, zoological gardens, or scientific purposes one pair of each species of big game and game birds upon payment of $5 fee. The holder of a general nonresident license may take with him out of the Province as trophies, heads, skins, and hoofs of big game legally killed by him.

British Columbia:

Deer, elk, moose, caribou, mountain sheep, mountain goat, hare, quail, partridge (English), pheasant, grouse, prairie chicken, ptarmigan, snipe, plover, duck, swan.

Exception: Heads, horns, and skins of big game lawfully killed by the shipper may be shipped under his hunting license.

Manitoba:

Deer, elk, moose, caribou, antelope, quail, grouse, partridge, prairie chicken, pheasant, plover, snipe, sandpiper, woodcock, duck.

Exception: Minister of agriculture and immigration may issue permit to export heads and skins of 2 of each species of animal and all game, except grouse, prairie chicken, and partridge, and not more than 100 geese and swans, or 50 ducks.

New Brunswick:[a]

Deer, moose, caribou, or any portion thereof; partridge, pheasant, woodcock, snipe, wood duck, dusky (black) duck, teal, goose, brant.

Exception: Surveyor-general may issue special license to export game alive or dead.

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[a] Except in the case of partridge the prohibition applies only to common carriers.

Export of Game Prohibited—Continued.

Newfoundland:

Caribou (antlers, heads, or skins), or partridge, willow or other grouse for sale.

Exceptions: Minister of marine and fisheries may issue special licenses to export gan breeding or scientific purposes. Nonresident may export 3 stag caribou under hunting li and export permit; resident may export antlers, head, or skin of caribou under export pe but not, in either case, for sale.

Nova Scotia:

Red deer, American elk, moose, moose skin, caribou, caribou skin, hare, rabbit, quail, Ca grouse (spruce partridge), ruffed grouse (birch partridge), pheasant, blackcock, caper ptarmigan, sharp-tailed grouse, woodcock, snipe, plover, curlew, yellowlegs, beach bird waders and sandpipers, blue-winged duck, teal, wood duck, American scoter (black coo scoter (sea coot), American eider, king-eider, harlequin duck, old squaw, whistler, Ame scaup duck, lesser scaup duck (bluebill), white-winged coot, American widgeon, gannet, g brant, heron, bittern, loon, gull, least tern, stormy petrel.

Exceptions: Holder of general license may take with him, out of Province, the mou head and remainder of the carcass of any moose lawfully shot by himself; and mo heads and dressed skins or live mammals or birds for propagation may be exported und permit from Provincial secretary.

Ontario:

All wild game animals and birds.

Exceptions: 1 bull moose and 1 bull caribou or head, skin, or parts thereof, between Oct 15 and December 1, and 2 deer, head, skin, or part thereof, in November, and 100 ducks be exported under nonresident hunting license, if shipping coupon and, if required, affi of lawful killing, be attached and contents of packages be open to view.

Prince Edward Island:

All game except geese and brant.

Exception: Nonresident licensee may carry out of Province 12 birds killed by himsel

Quebec:

Deer, moose, caribou, or parts thereof, except under permit from minister of colonization, and fisheries (fee not to exceed $5) and under tags attached to nonresident licenses.

Saskatchewan:

Deer, elk, moose, caribou, buffalo, sheep, goat, antelope, grouse, prairie chicken, ph ptarmigan, snipe, sandpiper, plover, curlew, shore bird, rail, coot, crane, duck, goose,

Exceptions: Commissioner of agriculture may grant permits to export for propaga public parks and zoological gardens or scientific purposes 1 pair of each species of bi and game birds upon payment of $5, or a specified number on application of another P or State. The holder of a general nonresident license may take with him out of the ince as trophies heads, skins, and hoofs of big game which he has legally killed.

Canada also has a general law prohibiting export of deer (exc those raised on private preserves), wild turkeys, quail, partric prairie fowl, and woodcock, and permitting each nonresident to ex two deer in a year at certain ports within fifteen days after the c of the open season, under permit of the collector of customs of the from which export is made. The ports of export are: Halifax Yarmouth, Nova Scotia; Macadam Junction, New Brunswick; Qu Montreal, and Ottawa, Quebec; Kingston, Niagara Falls, Fort E Windsor, Sault Ste. Marie, and Port Arthur, Ontario; and such ot as the minister of customs may designate.

Those who visit Canada to hunt, camp, etc., must deposit with customs officer at the port of entry an amount equal to the duty per cent of appraised value) on their guns, canoes, tents, cook utensils, and kodaks. If these articles are taken out within months at the same port, the deposit will be returned. But mem of shooting or fishing clubs that own preserves in Canada and filed a guaranty with the Canadian commissioner of customs may sent club membership certificates in lieu of making the deposit. T must, however, pay duty on all ammunition and provisions.

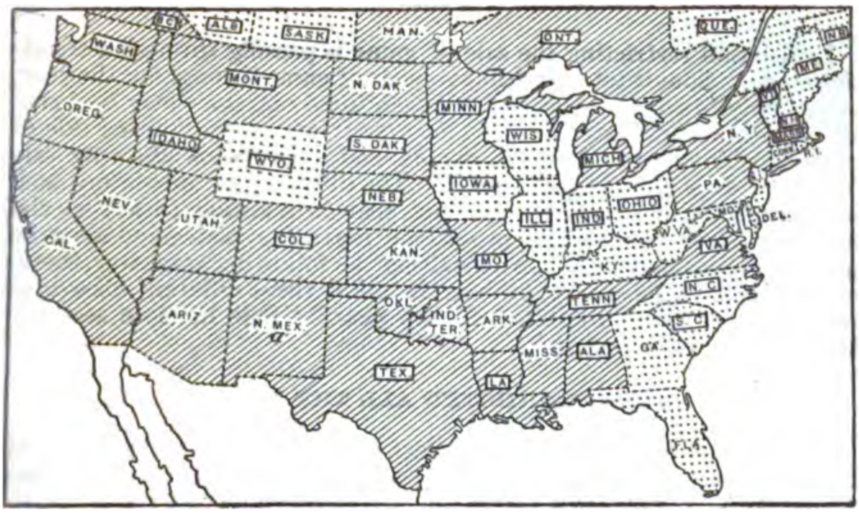

FIG. 1.—States and Provinces which prohibit export of game. Ruled areas indicate States which prohibit export of any game; dotted areas, States which prohibit export of certain kinds of game. Inclosed names indicate special exceptions permitting nonresident hunters to take out a limited amount of game. The letter *a* indicates prohibition of export for sale only. (For details, see pp. 27–32.)

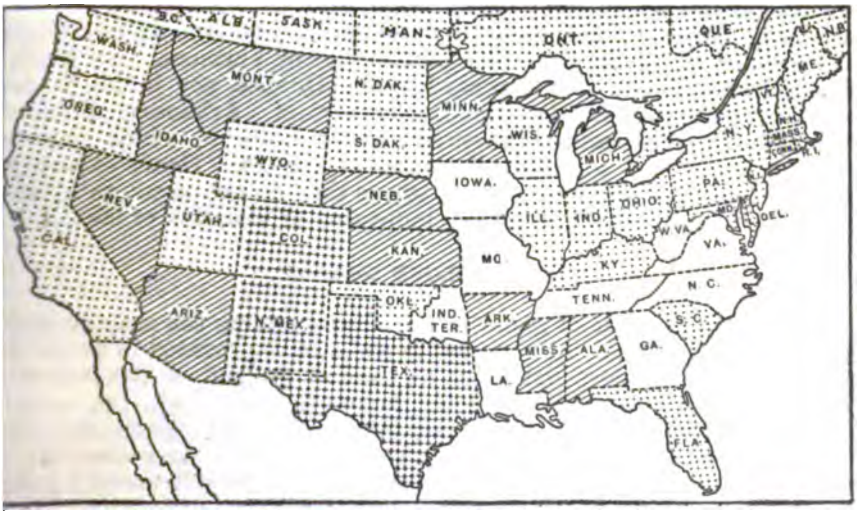

FIG. 2.—States and Provinces which prohibit sale of game throughout the year. Ruled areas indiate States prohibiting sale (resale in Nevada) of all protected game; crossed areas, States prohibiting ale of all protected game taken in the State; dotted areas, States prohibiting sale (resale in Delaare) of certain game; and blank areas, States that have no special sale prohibitions (except a few ocal provisions in North Carolina and Virginia). (For details, see pp. 35–39.)

MAPS SHOWING RESTRICTIONS ON EXPORT AND SALE IN 1907.

SALE.

Legislation restricting the sale of game is passing through a transition stage. Some States prohibit the sale of game throughout the year, others only in close season, and between these extremes may be found all gradations and exceptions, such as restrictions prohibiting sale of game outside the State or for export, and exemptions allowing sale for a few days in the close season. The difficulty of tabulating such regulations is increased by the fact that in addition to the special sale laws, close seasons, and provisions regarding possession must be taken into consideration. In consulting the following summary, therefore, it will be necessary to bear in mind three different classes of restrictions: "Sale prohibited all the year," "Sale in close season," and "Sale in open season."

SALE PROHIBITED ALL THE YEAR.

Forty-three States and Territories[a] and most of the Provinces of Canada now prohibit sale of all or certain kinds of game at all seasons. (See fig. 2, p. 33.) In Alabama, Arizona, Arkansas, Hawaii, Idaho, Kansas, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Mexico, and Texas the sale, and in Nevada the resale, of all game protected by the State law is prohibited; in South Dakota, of all big game; in Wisconsin, of all game except rabbits and squirrels; in California, Utah, Washington, and Manitoba, of all big game and upland game. In a few instances prohibitions against the sale of certain game are so general as to afford protection over a considerable area in adjoining States. Thus, ruffed grouse can not be sold in any State or Province along the Canadian border except Vermont, New York, Pennsylvania, Ohio, New Brunswick, and Quebec, nor in the States of Massachusetts, Rhode Island, Connecticut, Arkansas, Kansas, Nebraska, or Wisconsin. Practically every State in which prairie chickens occur now prohibits their sale or export. Hence exposure of these birds for sale in any State where they do not occur, as in any city east of Indianapolis, is strong indication of violation of law.

SALE IN CLOSE SEASON.

In general, the sale of game is prohibited during the close sea- but a brief additional open period is sometimes provided in order permit dealers to close out stock on hand at the end of the hunt season. In Colorado, Illinois, Iowa, Nebraska, New York, Tennessee, and British Columbia the sale season includes the open season and following five days for all or certain kinds of game. An extension ten days for sale is added to the open season in New Brunswick; teen days in Alaska, New Jersey, Pennsylvania, and Quebec; thirty days (for imported ruffed grouse) in Pennsylvania; sixty days Yukon; three months (for goose and brant) in New Brunswick, until the following 1st of January in Ontario.

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[a] Including Hawaii, but omitting Tennessee and Virginia, which prohibit only a few of their counties, and Alaska, which prohibits sale of only heads and trophies.

SALE IN OPEN SEASON.

In order to counteract a tendency on the part of market hunters to anticipate the opening of the season, the sale of certain game is sometimes prohibited at the beginning of the open season, as during the first two days in Illinois, the first three in Nova Scotia and Quebec, and the first month in British Columbia. Washington permits the sale of snipe and wildfowl (which may be killed from September 1 to March 1) only during November and then not more than 25 in a day.

The following table shows the kinds of game sale of which is *prohibited throughout the year.* The sale of all other game is so generally prohibited during the close season as to render a detailed enumeration unnecessary, but when an extension of a few days is added to the open season or a special season is provided for either possession or sale, attention is called to this exemption under the heading "Permitted."

Sale of Game Prohibited throughout the Year.

Alabama:

All game protected by the State.

Alaska:

Heads, hides, and skins of all protected game.

Permitted: Carcasses of all game may be sold during the open season and 15 days thereafter.

Arizona:

Deer, elk, antelope, sheep, goat (or meat, hide, head, or horns of said animals), quail, bobwhite, partridge, grouse, pheasant, wild turkey, dove, snipe, rail, duck, goose, brant.

Arkansas:

All "game, wild fowl, or birds whatsoever," except bears, rabbits, opossums, racoons, and squirrels.[a]

California:

Deer meat and hides of female deer, or those from which evidence of sex has been removed, quail, partridge, grouse, pheasant, sage hen, dove, ibis, snipe, plover, rail, or shore birds.

Colorado:

All game taken in the State.

Permitted: Domestic game may be sold by hotels, restaurants, etc., during the open season and five days thereafter, or during the limits of a storage permit. Imported game (under license) and game taken from licensed private parks and lakes may be sold at any time if accompanied by an invoice.

Connecticut:

Quail, ruffed grouse, woodcock, until October 1, 1911.

Delaware:

Quail, partridge, pheasant; buying for sale prohibited.

Florida:

Deer, deer hides, quail or partridge, wild turkey.

Hawaii:

All game protected by the Territory.

Idaho:

All game protected by the State.

Illinois:

Deer, squirrel (gray, red, fox, black), quail, Mexican blue quail, California mountain quail, California valley quail, ruffed grouse (pheasant), pinnated grouse (prairie chicken), pheasant (English ringneck, Chinese ringneck, green (Japanese), copper (Soemmering), tropogan [tragopan], silver, golden, Reeves, Elliot, Hungarian, Swinhoe, Amherst, melanotte, impeyan, argus); partridge (Hungarian, black Indian, caccabis, chukar), sand grouse; capercailzie, heath grouse (black grouse), wild turkey, duck, goose, brant, coot, rail.

Permitted: Deer bred in inclosures for market may be sold at any time; cock pheasants may be sold by breeders (under permit of State game commissioner) from November 1 to January 1, doves, woodcock, snipe, plover, coot, and rail may be sold from the third day of the open season to the fifth day of the close season, and squirrels, quail, ruffed grouse (partridges), pinnated grouse (prairie chickens), Mexican blue quail, California mountain quail, California valley quail, Hungarian partridges, capercailzie, heath grouse (black grouse), wild turkey, duck geese, and brant imported from other States from October 1 to February 1.

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[a] Squirrels killed in Ouachita and Union counties can not be sold therein.

Sale of Game Prohibited throughout the Year—Continued.

Indiana:

Quail.

Iowa:

Permitted: All game may be sold during the open season and five days thereafter.

Kansas:

Red squirrel, quail, partridge, grouse, pinnated grouse (prairie chicken), pheasant, dove, pl duck, goose, brant (buying also prohibited).

Kentucky:

Quail, partridge, grouse, pheasant, wild turkey, killed in the State.

Maine:

Deer, moose, or game birds for export. Ruffed grouse, woodcock, all protected ducks fo purpose.

Permitted: Deer may be sold by local dealers under license.

Maryland:

Anne Arundel—Quail, partridge, pheasant, woodcock, snipe, plover.

Frederick—Squirrel, partridge, pheasant, woodcock, taken in county.

Montgomery—Partridge, pheasant, wild turkey, for export.

Somerset—Rabbit, quail or partridge, woodcock, dead or alive, for export from the county, o any other purpose than as food within the county, or for propagating purposes.

Washington—Deer, squirrel, rabbit, partridge, pheasant, wild turkey, taken in county.

Wicomico, Worcester—Quail or partridge for export (both counties considered as one terri

Permitted: Baltimore City—Ruffed grouse, may be sold October 1-December 25.

Massachusetts:

Deer and quail taken in the State, ruffed grouse, heath hen, prairie chicken, sharp-tailed gr woodcock, and wood duck.

Permitted: Dealers or persons in the cold-storage business may sell quail lawfully imp during November and December.

Michigan:

All game protected by the State.

Minnesota:

All game protected by the State.

Mississippi:

All game protected by the State.

Missouri:

All game protected by the State.

Permitted: Game lawfully secured may be sold in county of capture. Imported game ma sold during open season.

Montana:

All game protected by the State.

Nebraska:

All game protected by the State.

Nevada:

Resale of all game.

New Hampshire:

Ruffed grouse or partridge, woodcock.

New Jersey:

Deer taken in the State until November 10, 1909.

Permitted: All other game may be sold during the open season and fifteen days there

New Mexico:

Deer, elk, antelope, mountain sheep, native or crested and bobwhite quail, partridge, pheasant, ptarmigan, wild turkey, turtle dove, wild pigeon, killed in the Territory.

New York:

Grouse and woodcock taken in the State, and quail taken in Delaware, Greene, Schoharie, Sullivan, and Ulster counties.

Permitted: Deer may be sold from October 1 to November 25. Elk, caribou, and imported or killed in a private park by the owner may be sold during the open deer; and quail, grouse, and woodcock (except as noted above) during the open seas January 1. Pheasants bred or liberated in Dutchess and Suffolk counties may be p any season in Greater New York for consumption but not for sale. Ducks, geese, br swans may be possessed during the open season and until March 1. On Long Islan geese, and swans may be possessed from October 1 to March 1, and brant until May rels, hares and rabbits, quail, grouse, and woodcock lawfully taken on Long Island possessed in the city of New York during the open season in the State at large.

North Dakota:

Deer, ruffed grouse, pinnated grouse, prairie chicken, sharp-tailed grouse, woodcock.

Ohio:

Squirrel, quail, ruffed grouse, Mongolian, English, or ringneck pheasant, dove, wood plover, rail, shore bird, duck, goose, swan, coot, mud hen, killed in the State for sa

Oklahoma:

Deer, antelope, quail, grouse, prairie chicken, wild turkey, dove.

Sale of Game Prohibited throughout the Year—Continued.

Oregon:

Deer, elk, moose, mountain sheep, silver-gray squirrel, quail, bobwhite quail, partridge, grouse, ruffed grouse, capercailzie, moor hen, pheasant (silver, golden, copper, green Japanese, Reeves, and ringneck), wild turkey, woodcock, upland plover, rail, duck, swan.

Permitted: Five deerskins, properly tagged, may be sold in a season by the hunter who originally secured them. Tags not issued after first five days of close season.

Pennsylvania:

Deer, quail, partridge, grouse, pheasant, taken in the State; wild turkey and woodcock (wherever taken).

Permitted: Squirrel, rabbit or hare, bear, dove, reedbird, blackbird, upland plover, Wilson or jack snipe, sandpiper, tatler, curlew, or any other shore bird, rail, coot or mud hen, duck, goose, brant, and swan taken in the State may be sold during the open season and fifteen days thereafter; ruffed grouse taken outside of the State may be sold during the open season and thirty days thereafter.

Rhode Island:

Quail, ruffed grouse, pheasant, woodcock.

South Carolina:

Deer until February 28, 1908; quail or partridge, pheasant, wild turkey, and woodcock, taken in the State, until March 1, 1911.

South Dakota:

Deer, elk, buffalo, mountain sheep.

Permitted: Skins, heads, and antlers of animals lawfully killed may be sold at any time.

Tennessee:

Dyer County—Wild turkey.

Permitted: All game may be sold in the State during the open season and five days thereafter.

Texas:

All game animals, hides and horns, wild birds, and wildfowl found in the State.

Utah:

Deer, elk, antelope, mountain sheep, quail, partridge, grouse, prairie chicken, sage hen, pheasant Mongolian, Chinese, and English pheasant, dove.

Permitted: 25 in all of shorebirds and waterfowl may be sold in a day to private parties.

Vermont:

Quail, ruffed grouse, pheasant or English partridge, English snipe, plover, woodcock, duck, goose, except for consumption as food in the State.[a]

Virginia:

English or Mongolian pheasant (except for propagation) until January 1, 1909.

Carroll, Grayson, Greenesville, Patrick, Sussex counties—Quail or partridge taken in county.

Clarke county—Quail, rabbit, squirrel, pheasant, wild turkey (outside of county).

Frederick, Shenandoah counties—Quail, ruffed grouse, wild turkey, woodcock (prohibition applies only to nonresidents of Virginia).

Page county—Quail (for export).

Washington:

Deer, elk, moose, caribou, mountain sheep, mountain goat, quail, partridge, grouse, prairie chicken, sage hen, ptarmigan, pheasant, Chinese or Mongolian pheasant, sandhill crane, plover, rail, swan, and all other game birds except ducks, geese, and brant.

Permitted: Ducks, geese, and brant may be sold during November, but only 25 in a day.

Wisconsin:

Venison, quail, partridge, grouse, prairie chicken, pheasant, Mongolian, Chinese, or English pheasant, snipe, plover, woodcock, duck, goose, brant, or other aquatic bird.

Wyoming:

Deer, elk, moose, antelope, mountain sheep, or skins, heads, antlers, or teeth thereof.

Permitted: Sale of 1 hide, 1 scalp, and 1 head of any big game, except moose, and 1 pair of elk tusks, on affidavit that they were taken from animals lawfully killed.

Alberta:

Mountain sheep, mountain goat, or prairie chicken, grouse, pheasant, ptarmigan, or other member of the Gallinæ, unless captured by owner. Heads of big game before they can be sold must be stamped by minister of agriculture at fees of $5 for elk, caribou, moose, and sheep, and $2 for deer, antelope, and goat.

British Columbia:

Elk, quail, grouse, ptarmigan, prairie chicken, English partridge, pheasant, swan, female and young of deer, moose, caribou, or mountain sheep, heads of moose, caribou, and sheep; also male deer on Vancouver Island.

Permitted: Male deer after September 1; male moose, caribou, mountain sheep, mountain goats, and hares after October 1; and snipe, plover, and ducks may be sold during the open season and five days thereafter.

Manitoba:

Deer, elk, moose, caribou, antelope (except heads and hides), quail, grouse, pheasant, partridge, prairie chicken, woodcock, plover, snipe, sandpiper.

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[a] Game from private game preserves stocked at owner's expense may be sold [illegible]

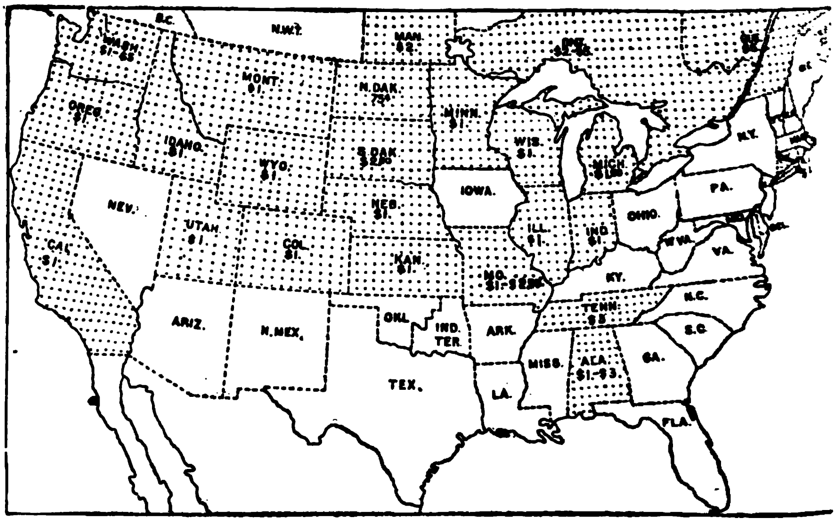

FIG. 3.—States and Provinces which require residents to obtain hunting licenses

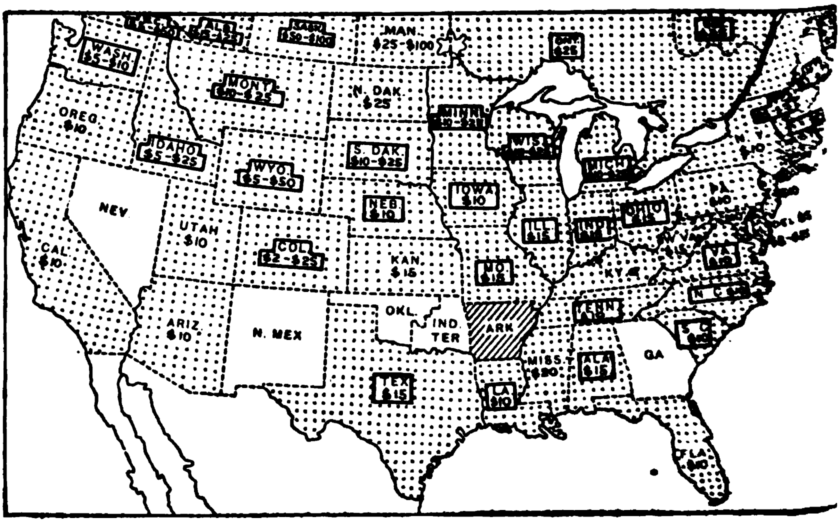

FIG. 4.—States and Provinces which require nonresidents to obtain hunting licenses

Inclosed names indicate that special privileges are granted for taking a limited a of game out of the State. Arkansas does not permit hunting by nonresidents tucky has no definite fee. (For details, see pp. 41-48.)

MAPS SHOWING LICENSE LAWS IN 1907.

Sale of Game Prohibited throughout the Year—Continued.

New Brunswick:

Permitted: Geese and brant may be sold during the open season and until March 1, and all other game during the open season and (under license from game warden) ten days thereafter.

Newfoundland:

Permitted: Caribou may be sold from August 1 to January 1.

Nova Scotia:

Deer, caribou to 1910, pheasant, blackcock, capercailzie, Canada grouse (spruce partridge), chukar partridge.

Permitted: Moose may be sold from October 1 to December 20. Any game bird other than those above mentioned during the open season with the exception of the first three days.

Ontario:

Quail, partridge, woodcock, snipe, subject to regulations of lieutenant-governor in council.

Permitted: All other game may be sold during the open season[a] and until the following January 1 under license.

Prince Edward Island:

Partridge until October 1, 1908.

Quebec:

Birch or swamp partridge, woodcock, until October 1, 1908.

Permitted: All other game may be sold after the third day of the open season and fifteen days after the close thereof. Hotels, restaurants, and clubs may serve, under license, all game lawfully taken, except birch or swamp partridge and woodcock. Skins and heads of animals lawfully taken and animals kept alive may be sold.

Saskatchewan:

Mountain sheep, mountain goat, or prairie chicken, grouse, pheasant, ptarmigan, or other member of the Gallinæ, unless captured by the owner.

Yukon:

Permitted: Deer, elk, moose, caribou, bison, musk oxen, sheep, and goats may be sold during the open season and sixty days thereafter.

LICENSES FOR HUNTING AND SHIPPING GAME.

In Arkansas nonresidents are not permitted to hunt, except on their
own premises, and in 43 States and Territories[b] and throughout Canada
licenses must be secured before nonresidents can hunt any or certain
kinds of game (see fig. 4). In 21 States and 4 Canadian Provinces
a like restriction is imposed on residents, but the fees are usually
very much smaller, and often are merely nominal (see fig. 3). The
fees for nonresident licenses for both big and small game range from
$10 in a number of States to $50 in Wyoming, British Columbia, New
Brunswick, and Newfoundland, and $100 in Saskatchewan; those for
resident licenses from 75 cents in North Dakota to $5 in Washington,
and $7 ($5 for moose and caribou and $2 for deer) in Ontario.

A new kind of hunting license, often known as the "alien" license,
has recently been adopted by several States to restrict hunting by per-
ons who are not citizens of the country. Thus Alabama, Florida,
New Hampshire, Pennsylvania, Louisiana, South Carolina, Texas, Utah,
nd Wyoming provide that all hunters who are unnaturalized resi-
ents of the State must obtain the same license required of nonresi-
ents; Massachusetts has a special $15 license for resident aliens, Con-
ecticut and Maine a $15, and Washington a $50 license for nonresi-
ent aliens, California a $25 license for all aliens, and Manitoba a $100
cense for all who are not British subjects.

Licenses are generally issued only for the open season, and thus
xpire at fixed dates. Some are necessarily very brief in duration.
Michigan issues a $25 nonresident deer license good only for twenty
ays in November; Vermont, a $15 nonresident deer license good only
or the last six consecutive week days of October. In a few instances
censes are issued at reduced rates for a week or for a few days. Of
his character are the $5 nonresident bird license, good for one week,
sued by British Columbia; the guest licenses, good for five days,

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[a] Seasons depend on regulations of game commission.

[b] Not including Georgia, in which a license must be secured to hunt for market.

issued by Alberta and Saskatchewan, and the daily licenses issued fo hunting birds in Colorado and any game in Lafayette County, Fla.

Eleven States issue licenses good only in the county named therein—Alabama, Colorado, Florida, Georgia (market hunting), Iowa, Maryland, Mississippi, Missouri, South Carolina, South Dakota, a Washington—with fees ranging from $1 for residents of Alabama Washington, to $50 for residents hunting ducks for market in So Carolina.

Twenty-eight States and 8 Canadian Provinces allow nonresident licensees to carry or ship out of the State or Province a limited amou of game, while this privilege is denied by 15 States and Territories a 1 Canadian Province. Maine, Michigan, and Montana issue expo permits additional to the hunting license.

Nonresident landowners or taxpayers are not required to pay th usual fee in Maryland (most counties),[a] Massachusetts, New Ham shire, New Jersey, North Dakota, Tennessee, Nova Scotia, and Pri Edward Island. But to secure this exemption in Massachusetts a New Hampshire the nonresident hunter must own land to the value o $500 and $1,000, respectively; in Tennessee, Nova Scotia, and Pri Edward Island he must pay a tax of at least $100, $30, or $25 pe annum, respectively, and in North Dakota must own or cultivat quarter section of land. Similar exemptions are made in the cas resident landowners and, in some instances, their tenants hunting their land in Alabama, California, Colorado (farming or grazing la only), Connecticut, Illinois, Indiana, Kansas, Montana, North Dak and Oregon, and no license is required of those hunting within th own county in Minnesota, Missouri, or Nebraska. Special exempti are made in favor of nonresident members of fish and game clu Kansas, Massachusetts, Rhode Island, and Quebec. In Virginia license is required of bona fide guests of residents, and in Ontari fee is charged for a guest license.

In Maine,[b] South Dakota, Wyoming, New Brunswick (on wild la and Nova Scotia nonresidents are not permitted to hunt big g unless accompanied by qualified guides, and in Colorado, Maine, M tana, Wyoming, Alberta, New Brunswick, Newfoundland, N Scotia, and Ontario guides are licensed. Maine, Alberta, and N Brunswick also license camp help. Nearly every State requires lic to have their licenses in personal possession while hunting and to ex them on demand of any warden (in New Hampshire of any perso

Details in regard to hunting licenses are given in the follo table. In every case the statement regarding the fee include amount charged for issuing the license by the county clerk or officer.

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[a] All the counties of Maryland allow nonresidents to hunt without license on tation of landowners, except Allegany, Caroline, Dorchester (unless relative rett, Kent, Somerset, Talbot, Wicomico (unless accompanied by a resident Worcester.

[b] On wild lands of the State, except from December 1 to 15.

[c] The following counties in North Carolina require hunters to obtain writt mission for hunting on lands other than their own: Anson (Lanesboro Tow Cherokee, Clay, Craven, Currituck, Davidson, Henderson, Hertford, Jones, M Martin, (Cross Roads, New Hope, Goose Nest, Hamilton, and Poplar Poi ships), Montgomery, Nash, Randolph (townships of Back Creek, Frankli [quail], and part of Columbia), Richmond (Mineral Springs and Wolfpit tow Robeson (south of the Carolina Central Railroad and east of the Carolina N Railroad), Rowan, Rutherford (Rutherford Township), Union, Wayne, and Y

Details of hunting licenses, with bag limits, and export regulations.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
Alabama	Nonresident	$15.00	Probate judge of the county.	Expires Dec. 31	1 deer, 2 turkeys, 25 of each other kind of birds a day.	Nonresident licensee may carry out of State or have carried to him game lawfully killed by him.
	Alien	15.00	do	do		
	Resident	3.00	do	State license; required to hunt outside of county of residence, except on lands owned or leased by hunter. Expires Dec. 31.		
	Resident	1.00	do	County license; required to hunt outside of voting precinct, ward, or beat of hunter, except on lands owned or leased by him. Expires Dec. 31.		
Alaska					2 moose, 4 each of caribou, sheep, goats, large brown bears, 8 deer a year; 10 grouse or ptarmigan, 25 shore birds or waterfowl a day.	In discretion of Secretary of Agriculture, who issues permit in each case.
Arizona	Nonresident	10.00	Fish and game commissioner or county recorder.	Deer only	3 deer a season, 25 quail a day.	No export.
Arkansas				Nonresidents not permitted to hunt.[a]		Do.
California	Nonresident	10.00	Board of fish commissioners, county clerks.	Expires not later than June 30. Land owners hunting on their own lands exempt.	2 deer a season; 25 each of quail, partridges, snipe, plover, curlew, shore-birds, rail, ibises, and doves, and 35 ducks a day.	Do.
	Alien	25.00	do	do		
	Resident	1.00	do	do		
Colorado	Nonresident	25.00	Commissioner of game	Expires Dec. 31	1 deer a season; 25 ducks a day, 50 in possession at once; 25 other birds a day, 50 in possession at once.	Permit from commissioner required.
	do	2.00	do	County license for birds, $2 first day; each subsequent day $1. Expires Dec. 31.		
	Resident	1.00	Commissioner of game or county clerk.	Expires Dec. 31. Owners of farms or grazing lands hunting on their premises exempt.		
	Guide	5.00	Commissioner of game	Expires Dec. 31. Must have in addition a State license.		
Connecticut[b]	Nonresident	10.25	Town city, or borough clerk.	Good for 1 year from date of issue.	5 ruffed grouse a day, 36 a year; 35 rail, 50 each of plover, snipe, shore-birds a day.	No quail, ruffed grouse, or woodcock.
	Alien	15.25	do	do		
	Resident	1.10	do	do		

[a] But see State *v.* Mallory, 88 S. W. 955, deciding that nonresidents may hunt on their own land.

[b] No license is required of a bona fide resident of Connecticut, or his lineal descendants, hunting on land occupied by him and used for agricultural purposes.

Details of hunting licenses, with bag limits, and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
Delaware	Nonresident	$5.00	Delaware Game Protective Association.	$2 for each subsequent year.		No rabbit, quail, partridge, robin, woodcock, Wilson snipe.
Florida	Noncitizen	10.00	Clerk of circuit court	County license. Expires Mar. 1.[a]	5 deer, 5 turkeys a year; 20 quail, 2 turkeys by individual or 40 quail, 4 turkeys by party a day.	No deer, quail, or wild turkeys.
Georgia	Market hunting.	25.00	Ordinary of county	County license; permits killing for sale. Expires Dec. 31.	40 doves a day	No quail.
Idaho	Nonresident	25.00	State warden, deputy probate judge, or justice of the peace.	Expires Jan. 31	2 deer, 1 ibex, 1 goat, 1 sheep, 1 elk a season; 18 quail, 12 each of sage hens, partridges, pheasants, grouse, prairie chickens, 24 ducks, 8 geese a day.	2 deer, 1 ibex, 1 mountain goat, 1 mountain sheep, 1 elk. No birds.
	Nonresident	5.00	do	Birds only. Expires Jan. 31.		
	Resident	1.00	do	Expires Jan. 31. Not required of females.		
Illinois	Nonresident	15.50	City, village, or county clerk.	Expires June 1	15 squirrels; 20 rail, ducks, geese, brant, coots, or other waterfowl and 15 other birds a day.	50 birds of all kinds.
	Resident	1.00	do	Expires June 1. Not required of owners and tenants of farms hunting on their lands.		
Indiana	Nonresident	15.50	Clerk of circuit court	Good for 1 year.	15 quail; 15 ducks or other waterfowl a day; 45 birds in possession as result of 3 or more days' consecutive hunting.	15 birds of all kinds, or 45 in case of 3 or more days' consecutive hunting.
	Resident	1.00	Commissioner of fisheries and game, clerk of circuit court.	Good for 1 year. Not required of landowners hunting on their own lands, nor of their children or tenants, nor for hunting rabbits in township of residence.		
Iowa	Nonresident	10.50	County auditor	County license. Expires Jan. 1.	25 each of quail, prairie chickens, ruffed grouse or pheasants, woodcock, wild turkeys, ducks, geese, brant a day.	25 of all kinds of game.
Kansas	Nonresident	15.00	Secretary of state	Expires June 30. Not required of owners of land and members of hunting club hunting on their own premises.	20 each of quail, plover, duck; 15 each of grouse, prairie chickens; 10 each of geese, brant a day.	No export.
	Resident	1.00	County clerk	do		
Kentucky	Nonresident		do	Expires 1 year from date of issue. Same fee as resident of Kentucky is subject to in State of nonresident.		Do.
Louisiana	Nonresident	10.00	Sheriff	Required of nonresidents and unnaturalized residents.	6 deer a season; 75 snipe and ducks, 25 other birds a day.	1 deer, 12 birds.
	Market hunting	25.00	do			
Maine	Nonresident	15.00	Commissioners of inland fisheries and game	All game during October, November, and December. Game that may be shot before Oct. 1 [illegible]	1 moose, 2 deer a season (except in Cumberland, Knox, Kennebec, Lincoln, Sagadahoc, Waldo, and York counties [illegible]	1 moose, 2 deer, 10 each of partridges, ducks, and woodcock
	[illegible]	[illegible]	do	[illegible]		

				resided in State 2 years continuously prior to passage of law or pay taxes in State.	camps, limit 6); 15 each of ruffed grouse, woodcock, plover, snipe, ducks, and 70 sandpipers a day.	
	Camp keeper	5.00	....do			
	Guide (nonresident).	20.00	....do	Expires Dec. 31. Guide to be registered, and to guide not more than 5 persons at a time.		
	Guide (resident)	1.00	....do	....do		
	Shipment		....do	Moose, $5; deer, $2; pair of game birds, 50 cents. Permits shipping home or to hospital in State.		
Maryland	Nonresident	5.00 25.50	Clerk of circuit court	Separate county laws[b]		Local laws.
Massachusetts	Alien	15.00	City and town clerk	Required of unnaturalized foreign-born residents. Nonresident aliens not permitted to hunt.		6 birds.
	Nonresident	[c] 10.00	Commissioner of fisheries and game.	Expires Dec. 31. Not required of owners of real estate to value of $500.		
Michigan	Nonresident	25.00	County clerk	Deer. Good for season	2 deer a year; 12 each of quail, grouse, spruce hen a day, 50 in possession at a time; 25 ducks, waterfowl, snipe, plover, woodcock a day, 75 in possession at a time.	1 deer under license and shipping permit.
	Nonresident	10.00	....do	Small game only. Good for season. Not required of persons hunting on their own land.		
	Resident	1.50	....do	Deer. Good for season		
	Export	10.00	State game and fish warden.			Nonresident landowner and member of a club maintaining a game preserve may export 50 ducks or migratory birds killed by him on said premises.
Minnesota	Nonresident	25.00	Board of game and fish commissioners.	Game animals. Expires Dec. 31.	1 deer (nonresident), 2 deer (resident), 1 moose a season, 15 birds a day.	1 deer, 25 birds.
	Nonresident	10.00	....do	Game birds. Expires Dec. 31		
	Resident	1.00	County auditor	Not required for county of residence. Expires Dec. 15.		

[a] Not applicable to counties having special game laws. Nonresidents of Lafayette and Sumter counties required to secure license of game warden and pay therefor $1 per day. Hernando County issues a $10 nonresident and a $1 resident license, both good for the season, and Clay County issues a $10 guide license; while no one is permitted to hunt in Taylor County who is between the ages of 18 and 60 and does not pay taxes or work on the roads in the county, nor in Wakulla County if between the ages of 21 and 55 and not a taxpayer of the State.

[b] County and local licenses are issued at the following rates, including clerk fees: Allegany, $10.50; Baltimore, $5.25; Calvert, $10.50; Caroline, $5; Carroll, $10.50; Cecil (upland game and shore birds), $5.50; Charles (rabbit, quail, and woodcock), $20.50; Dorchester, $5; Frederick, $15.50; Garrett, $25.50; Harford, $10.50; Howard, $8; Kent, $15.50 (if invited by landowner, $5.50); Montgomery, $15.50; Patuxent River, $11; Prince George, $20.50; Queen Anne, $5; St. Mary, $20.50; Somerset, $5.25, nonresident of the State, $10.50; Talbot, $10; Washington, $10.50 (not required of residents of Maryland or the District of Columbia); Wicomico, $10.50; Worcester (wildfowl), $10. Guests of landowners require no licenses, except in Allegany, Caroline, Dorchester, Garrett, Kent, Talbot, and Worcester counties. Nonresident taxpayers are usually exempt. In Somerset County residents are required to take out a $1.25 license, except to hunt on their own land, and in several other counties residents pay fowling licenses as follows: Anne Arundel, pusher, $2; booby and brush blind, $5; Cecil, Elk, and Bohemia rivers, sneak boat, $5.50, sink box, $10.50; Susquehanna Flats, sneak boat, $5.75, sink box, $20.75; Harford, sneak boat, $5.75, sink box, $20.75; Patuxent River, pusher, $2.50.

[c] Members of incorporated game clubs owning real estate to the value of $1,000 and organized prior to passage of law pay a fee of only $1.

Details of hunting licenses, with bag limits, and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
Mississippi	Nonresident	$20.00	Sheriff	County license. Good for season. Landowners and their nonresident relatives and friends, hunting on their lands exempt.	1 deer a day, 5 in a season; 20 each of quail, wild turkeys, plover, tatlers, chorooks, grosbecs, coots, poule d'eau, rails, ducks, swan, geese, brant a day.	No export.
Missouri	Nonresident	15.00	Circuit court clerk or license collector.	County license. Good for 1 year.	1 deer, 2 turkeys, 25 of any other species a day; or 2 deer, 4 turkeys, 50 of any other species in possession at a time.	1 deer, 2 turkeys, 25 quail, 25 ducks.
	Resident	1.00	do	Good for 1 year. Required for hunting in counties adjoining county or city of residence.		
	Resident	2.50	do	County license. Good for 1 year. Required for hunting in counties not adjoining residence.		
Montana	Nonresident	25.00	State game and fish warden or deputy.	Expires Dec. 31	3 deer, 1 elk, 1 antelope, 1 goat, 1 sheep a season; 10 each of grouse, prairie chickens, fool hens, pheasants, sage hens, partridges, turtle doves a day.	Number permitted to be killed under hunting license.
	Nonresident	10.00	do	Birds only. Expires Dec. 31		
	Resident[a]	1.00	State game and fish warden, or deputy, or justice of the peace.	Expires Dec. 31. Not required of landowners hunting on their own premises.		
	Guide	10.00	State game and fish warden.	Good for 1 year		
	Shipping	.50	do	Permits limited export in open season.		
Nebraska	Nonresident	10.00	Game and fish commissioner or county clerk.	Expires Dec. 31	10 geese or brant, 25 other birds (in Sept. only 10 prairie chickens or grouse) a day; 10 geese or brant, 50 other birds in possession at a time.	50 birds.
	Resident	1.00	do	Necessary outside of county of domicile. Expires Dec. 31.		
Nevada					3 deer, 3 antelope a season; 20 quail, 20 ducks, 20 sage hens, 6 grouse, 5 plover, and 15 snipe a day.	No export.

					a season; in Orange County, 12 quail, 12 grouse, 12 woodcock a day, 36 a season.	export.
North Carolina	Nonresident[b]	10.25	Clerk of superior court	Good for season only	Separate county laws	50 partridges or quail, 12 grouse, 2 turkeys, 50 beach birds or snipe.
North Dakota	Nonresident	25.00	County auditor	Expires Dec. 31. Nonresident owning or cultivating a quarter section of land may take out resident license in county where land lies.	5 deer a season; 25 birds a day	No export.
	Resident[c]	.75	do	Expires Dec. 31. Citizen hunting on his own land exempt.		
Ohio	Nonresident	15.25	County clerk	Expires Dec. 15	10 squirrels; 18 each of quail, doves, woodcock, snipe, plover, rail, shore birds, geese; 25 ducks; 6 each of pheasants, prairie chickens, or grouse a day.	50 animals and birds.
Oklahoma						No export.
Oregon	Nonresident	10.00	County clerk	Good for one year. Not required of landowners hunting on their own premises.	5 deer a season; 10 each of quail (east of Cascades, 6 a day, 12 a week), grouse, prairie chickens, ring-neck pheasants a day; 50 ducks a week.	No export allowed, except by Washington hunters, who may take one day's bag.
	Market hunting.	10.00	Game and forestry warden.	Nonresident. Expires Dec. 31.		
	Resident	1.00	County clerk	Good for one year. Not required of landowners hunting on their own premises.		
Pennsylvania	Nonresident	10.00	County treasurer	Required of nonresidents and unnaturalized residents. Good for year of issue.	1 deer a season, 6 squirrels a day; 5 each of ruffed grouse, introduced pheasants, 10 woodcock a day, 20 a week, 50 a season; 10 quail a day, 40 a week, 75 a season; 1 wild turkey a day, 4 a season.	No export.
Rhode Island	Nonresident	[d]10.00	Secretary of State	Expires Dec. 31		No quail, ruffed grouse, or woodcock.
South Carolina	Nonresident	10.25	County clerk	Required of nonresidents and aliens. Good for season.		Licensee may carry from the State openly in hand 2 deer, 4 wild turkeys, 12 ruffed grouse, 50 each of partridges (quail), beach birds, ducks, geese.
	Market hunting	50.00	County treasurer	County license for residents hunting wild fowl on public lands and navigable waters. Expires Dec. 31.		

[a] United States soldiers stationed in the State and officers of the United States forest service classed with residents.

[b] A $25 license is required for shooting wildfowl from blind, battery, box, float, or raft in waters of Dare County lying north of an east-and-west line passing through northern end of Roanoke Island; south of said line 2 nonresidents may shoot from such devices belonging to a resident if a $5 tax has been paid upon same.

[c] Residents of the State under 16 years may hunt without license, but must have written consent of their parents.

[d] Members of incorporated game clubs owning real estate to the value of $1,000 and organized prior to passage of law pay a fee of only $1.

Details of hunting licenses, with bag limits, and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
South Dakota	Nonresident	$25.00	County treasurer	County license for big game. Issued Nov. 1. Expires Dec. 31. Nonresident licensee must be in charge of guide.	2 deer, 1 elk, 1 buffalo, 1 sheep a year; 15 birds a day.	2 deer, 1 elk, 1 buffalo, 1 sheep, 15 birds.
	Resident	2.50	do			
	Nonresident	10.00	do	State license (birds) for season.		
Tennessee	Nonresident	10.25	State game warden	Expires Dec. 31. Not required of property owners who pay $100 in taxes.	50 ducks; 30 of all other birds in aggregate a day.	50 ducks; 30 of all other birds in aggregate.
	Resident	3.00	do	Required when hunting on lands with verbal permission of owner. Expires Dec. 31.		
	Market hunting.	25.00	do	Annual license; $200 bond required.		
Texas	Noncitizen	15.00	Game, fish, and oyster commissioner.	Expires Dec. 31	3 deer a season; 25 birds a day. (3 wild turkeys Dec. to Feb.).	Nonresident licensee may take out 3 deer, 75 ducks, 25 other birds.
Utah	Nonresident	10.00	State fish and game commissioner or deputy.	Required also of aliens; good to Jan. 31.	2 deer a season (residents only), 12 quail a day (in Davis, Salt Lake, Utah, and Weber counties); 8 each of partridges, pheasants, prairie chickens, sage hens, grouse, doves, and 25 in all of snipe, shorebirds, ducks, geese, brant, swans, a day.	No export.
	Resident	1.00	State fish and game commissioner or depury; justice of the peace.	Not required of females; good to Jan. 31.		
Vermont	Nonresident	[a] 15.00	State fish and game commissioner.	Deer only [b]	1 deer and 35 ruffed grouse or woodcock a season; 5 each of gray squirrels, quail, ruffed grouse, pheasants, woodcock, plover, English snipe, geese, and 20 ducks a day.	1 deer; no birds.
	Nonresident	5.00	Town clerk	Birds only [b]		
Virginia[c]	Nonresident	10.00	County clerk	Good in open season in the 6 months following issue.		1 deer, 50 quail, 10 pheasants or grouse, 8 wild turkeys, 30 waterfowl, 25 of each or 100 in all, plover, snipe, sand-

	Nonresident	10.00	do	All game except deer	2 for residents; 10 grouse, prairie chickens, woodcock, 10 geese or brant, 15 partridges, 25 ducks, plover, snipe, coots, rail a day.	
	Resident [d]	1.00	County clerk			
Wyoming	Nonresident	50.00	Justice of the peace	Expires Dec. 31. Required also of aliens. Each licensee must employ guide.	2 deer, 1 elk, 1 antelope, 1 sheep a season; 12 birds a day.	2 deer, 1 elk, 1 antelope, 1 sheep.
	Nonresident	5.00	do	Birds only. Expires Dec. 31		
	Resident [e]	2.00	do	Expires Dec. 31		
	Resident	1.00	do	Birds only. Expires Dec. 31		
	Guide [f]	10.00	do	Good for one year.		
Alberta	Nonresident	25.00	Game guardian	Expires Dec. 31	1 deer, 1 elk, 1 moose, 1 caribou, 2 antelope a season; 20 grouse, partridges, pheasants, prairie chickens, ptarmigan a day, or 200 a season.	Under general license, trophies of big game legally killed.
	Nonresident	15.00	do	Birds only. Expires Dec. 31		
	Guest	2.00	do	Guests of residents hunting with them. Good for 5 days.		
	Guide, camp help.	5.00	do	Maximum fee. Expires Dec. 31.		
	Resident	2.50	do	Big game. Expires Dec. 31 [g]		
British Columbia	Nonresident	50.00	Game warden or any government agent.	Members of army or navy or Canadian militia in actual service exempt.	5 deer, 2 elk, 2 moose, 5 caribou, 5 goats, 3 sheep, 250 ducks and snipe a season.	Heads, hides, and horns of animals legally killed by nonresident licensees.
	Nonresident	5.00	do	Birds only. Good for 1 week		
Manitoba	Alien	100.00	Minister of agriculture and immigration.	Nonresident. Good for season.	1 deer, 1 elk, 1 moose, 1 caribou, 1 antelope a season; 20 in all of grouse, partridges, prairie chickens a day, 100 a season; 50 ducks a day in September.	No export. But see p. 31.
	Nonresideut	25.00	do	British subject		
	Resident	2.00	do	Animals only		
New Brunswick	Nonresident	50.00	Surveyor-general; chief game commissioner; any game warden.	Moose, caribou, and deer [h]		
	Nonresident	10.00	Surveyor-general	Deer only. Discretionary with surveyor-general.	2 deer, 1 moose, 1 caribou a season.	No partridge; other game under permit.
	Nonresident	50.00	Surveyor-general; chief game commissioner; any game warden.	In Westmoreland County		
	Resident	2.00	do	Moose, caribou, and deer.		
	Resident	.25	do	In Westmoreland County		
	Guide	2.00	do	Resident accompanying anyone hunting big game.		

[a] A nonresident holding a bird license may secure a deer license by paying $10 additional.

[b] Not required of anyone owning real estate in Vermont, occupying the same as a domicile at least three months in the year, and paying taxes thereon.

[c] Guests not required to procure license to hunt on land of host, provided the host receives no compensation, directly or indirectly, from such guest.

[d] Bona fide settlers who have not resided in the State 1 year may take out a special resident license.

[e] Applicant must be an elector of the State; child or ward, over 14 years, of an elector; or a soldier or sailor of the United States and an elector thereof, stationed 1 year at a post in the State. Soldier and sailor must employ guide.

[f] Guide must be citizen and qualified elector of State, must act as assistant game warden, and is equally responsible with employer for violation of law.

[g] Not required in Northern Alberta.

[h] Nonresidents hunting big game on wild lands must be in charge of registered guide.

Details of hunting licenses, with bag limits, and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
New Brunswick	Camp help	$1.00	Surveyor-general; chief game commissioner; any game warden.	Resident		
	Camp help	50.00	do	Nonresident		
Newfoundland[a]	Nonresident	51.00	Stipendiary magistrate; justice of the peace; minister of marine.	Good for season. Licensee can not employ unlicensed guide.	3 caribou	3 caribou under license and permit.
	Guide	50.00	do	Nonresident. Resident guide licenses free.		
Nova Scotia[b]	Nonresident	30.00	Provincial secretary, clerk of municipality, or agent of game society.	Expires Aug. 1. Must employ licensed guide.	1 moose a season; 5 ruffed grouse, 10 woodcock a day.	Mounted head and rest of carcass of any moose lawfully killed by licensee.
	Guide	2.00	Provincial secretary or agent, agent of game society.	Resident. Expires Aug. 1		
Ontario	Nonresident[c]	25.00	Superintendent of game and fisheries.		2 deer, 1 bull moose, 1 bull caribou a season.	2 deer, 1 bull moose, 1 bull caribou, 100 ducks.
	Resident	5.00	do	Moose and caribou		
	Resident	2.00	do	Deer		
	Guest		do	No fee required		
	Guide	2.00?	do	Optional with chief warden and game commissioners.		
Prince Edward Island.	Nonresident[d]	15.00	Game inspector	All game. Expires 1 year after date.		12 birds, (except geese and brant, on which no limit is placed.)
Quebec	Nonresident[e]	25.00	Minister of colonization, mines, and fisheries or his agents.	All game	Zone 1: 2 deer, 2 caribou, 1 moose a season. Zone 2: 2 deer, 1 moose, 4 caribou a season.	
	Resident	5.00	do	3 deer and 3 caribou additional to bag limit.		
Saskatchewan	Nonresident	100.00	Game guardian	Expires Dec. 31	2 deer, 2 elk, 2 moose, 2 caribou a season; [f] 10 grouse, partridges, pheasants, prairie chickens, ptarmigan a day, or 100 a season.	Under general license, trophies of big game legally killed.
	Nonresident	50.00	do	Birds only. Expires Dec. 31.		
	Guest	1.00	do	Guests of residents hunting with them. Good for 5 days.		
Yukon					6 deer, 6 moose, 2 elk, 2 musk oxen a season.	

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[a] Any officer of a British war ship stationed on the coast of Newfoundland for fisheries protection may obtain a free hunting license good for six weeks of open season and may employ an unlicensed guide.

[b] Former residents, in Government employ, who are members of the game society, require no license. Nonresident landowners paying $30 or more annual taxes require licenses, but pay no fee. Officers of the army or navy stationed in Nova Scotia pay $5 fee, unless members of the game society, in which case they are exempt.

[c] Lieutenant governor in council authorized to increase nonresident license fee as to deer, moose, and caribou to $50, and to provide licenses for residents of other Provinces [illegible] of Ontario.

[d] [illegible] pay a fee of only $5.

[e] [illegible]

PPENDIX.—TABLES SHOWING CLOSE SEASONS FOR GAME UNDER COUNTY LAWS.

In several States local laws prevail to such an extent as to require ecial tables. The county laws of Virginia and Tennessee were pealed in 1903 and those of Alabama in 1907, but local laws are still e rule in Maryland and North Carolina. In California, under the unty government act of April 1, 1897, boards of supervisors were thorized to shorten the open seasons for game, and this privilege was ercised so generally that the seasons fixed by the State law were mate lly modified. In July, 1905, the district court of appeal of the second pellate district, in passing on the constitutionality of the dove ordinnce of Los Angeles County (Ex parte Prindle, 1 Cal. App. Dec., 280), clared this authority abrogated by an amendment to the constitution rt. IV, sec. 25½) adopted in 1902, and in July, 1906, the superior court San Bernardino County held the game ordinance of that county alid on the same grounds. Consequently these local seasons are here included.

n the following table the season for each kind of game under the te law (if any) is first given, after which the local exceptions are ted by counties:

MARYLAND.

Close seasons for game under county laws.[a]

Kinds of game.	Close seasons.
:	
llegany	Jan. 1-Oct. 15.
arrett	Jan. 1-Oct. 1.
Vashington	Jan. 1-Nov. 1.
rrel, Dec. 1-Sept. 1 (ex- t as follows):	
llegany, Cecil	Jan. 1-Sept. 1.
nne Arundel	Dec. 24-Sept. 1.
altimore	Nov. 2-Sept. 15.
aroline	Jan. 16-Sept. 1.
rederick (gray or fox)	Nov. 15-Sept 1.
arford	Dec. 1-Sept. 1.
ent	All the year.
ontgomery (gray)	Dec. 15-Aug. 1.
ashington	Dec. 25-Sept. 15.
icomico	Feb. 15-Sept. 1.
arrett, Prince George	Unprotected.
it:	
altimore, Baltimore City (sale), Calvert, Frederick, Kent, Washington.	Dec. 25-Nov. 1.
llegany	Dec. 1-Nov. 1.
nne Arundel, Cecil, Queen Anne.	Dec. 25-Nov. 15.
aroline	Jan. 16-Nov. 15.
Rabbit—Continued.	
Carroll, Howard	Dec. 25-Nov. 10.
Charles	Jan. 15-Oct. 15.
Dorchester, Talbot	Jan. 1-Nov. 1.
Garrett	Feb. 1-Nov. 1.
Harford	Dec. 1-Nov. 1.
Montgomery[b]	Dec. 20-Nov. 1.
Prince George	Dec. 26-Nov. 9.
St. Mary	Jan. 16-Nov. 1.
Somerset	Jan. 1-Nov. 15.
Wicomico, Worcester	Jan. 15-Nov. 15.
Quail (or partridge):	
Baltimore, Baltimore City, Charles, Frederick, Kent, St. Mary, Washington.	Dec. 25-Nov. 1.
Allegany	Dec. 1-Nov. 1.
Anne Arundel. Cecil, Queen Anne.	Dec. 25-Nov. 15.
Calvert	Jan. 11-Nov. 1.
Caroline	Jan. 16-Nov. 15.
Carroll, Howard	Dec. 25-Nov. 10.
Dorchester, Talbot	Jan. 1-Nov. 1.
Garrett	Until Oct. 1, 1908.
Harford	Dec. 1-Nov. 1.
Montgomery	Dec. 20-Nov. 1.

is unlawful to hunt on election day in Baltimore, Frederick, or Harford counties, and in Fred- ounty it is unlawful to hunt with gun or rifle Oct. 10-Nov. 1.

lling by other means than shooting prohibited Nov. 1-Jan. 15.

MARYLAND—Continued.

Close seasons for game under county laws—Continued.

Kinds of game.	Close season.
Quail (or partridge)—Cont'd.	
Prince George	Dec. 26-Nov. 9.[c]
Somerset, Wicomico, Worcester.	Jan. 15-Nov. 15.
Ruffed grouse (or pheasant):	
Baltimore, Calvert, Caroline, Charles, Frederick, Kent, Talbot.	Dec. 25-Nov. 1.
Allegany	Dec. 1-Nov. 1.
Anne Arundel, Cecil	Dec. 25-Nov. 15.
Carroll, Howard, Queen Anne, St. Mary.	Dec. 25-Nov. 10.
Baltimore City (sale)	Dec. 25-Oct. 1.
Dorchester, Wicomico, Worcester.	Feb. 1-Nov. 10.
Garrett	To Oct. 1, 1908.
Harford	Dec. 1-Nov. 1.
Montgomery	Jan. 1-Sept. 1.
Prince George	Dec. 26-Nov. 9.
Washington	Dec. 25-Aug. 12.
Somerset	Unprotected.
English pheasant, Mongolian pheasant, Dec. 25-Nov. 1 (except as follows):	
Anne Arundel	Dec. 25-Nov. 15.
Howard	Dec. 25-Nov. 10.
Dorchester	Feb. 1-Nov. 10.
Garrett	Until Oct. 1, 1908.
Prince George	Dec. 26-Nov. 10.
Wicomico, Worcester	Feb. 1-Nov. 10.
Wild turkey:	
Baltimore, Baltimore City (sale), Calvert, Caroline, Charles, Prince George, Talbot.	Dec. 25-Nov. 1.
Allegany	Dec. 1-Nov. 1.
Dorchester, Wicomico, Worcester.[a]	Feb. 1-Nov. 10.
Frederick	Jan. 15-Nov. 15.
Garrett	Until Oct. 1, 1908.
Howard	Dec. 25-Nov. 10.
Kent	All the year.
Montgomery	Mar. 1-Nov. 1.
Washington	Jan. 1-Nov. 1.
Anne Arundel, Carroll, Cecil, Harford, Queen Anne, St. Mary, Somerset.	Unprotected.
Dove, Dec. 25-Aug. 15 (except as follows):	
Carroll, Frederick, Wicomico.	All the year.
Dorchester	Jan. 1-Aug. 1.
Kent	Dec. 25-Aug. 1.
Somerset	Jan. 1-Aug. 10.
Washington	Dec. 25-Aug. 12.
Wild pigeon, Kent County	Dec. 25-Aug. 1.
Woodcock:	
Baltimore, Baltimore City (sale), Calvert, Frederick, Howard, Kent.	Dec. 25-Nov. 1.[b]
Allegany	Dec. 1-Nov. 1.
Anne Arundel	Aug. 16-June 14.
Caroline	Jan. 16-July 4.
Carroll	Dec. 25-July 15.
Cecil	Dec. 25-Nov. 15.
Charles	Feb. 24-July 5.
Dorchester, Montgomery	Jan. 1-July 1.
Garrett	Dec. 1-Oct. 1.
Harford	Dec. 1-July 1.
Woodcock—Continued.	
Prince George	Dec. 26-J
Queen Anne	Feb. 1-Jul
St. Mary	Feb. 2
Somerset	Jan. 1-Ju
Talbot	Jan. 1-Ju
Washington	Dec. 25-
Wicomico	Feb. 1-J
Worcester	Feb. 1-N
Plover, May 1-Aug. 15 (except as follows):	
Anne Arundel	Aug. 16-Ma
Carroll	May 1-Se
Kent	Dec. 25-Au
Prince George	May 1-
Somerset	May 1-
Wicomico	Jan. 15-N
Worcester	Unprotected.
Snipe, May 1-Aug. 15 (except as follows):	
Anne Arundel	Aug. 16-Ma
Carroll	May 1-Se
Kent	June 1-Ma
Prince George	May 1-Se
Somerset	May 1-
Wicomico	Jan. 15-N
Worcester	Unprotected.
Sora rail or ortolan, Nov. 1-Sept. 1 (except as follows):	
Anne Arundel and Prince George—	
Patapsco or Potomac	Nov. 1-
Patuxent River	Jan. 1-
Caroline, Kent	Jan. 16-
Cecil	Dec. 25-
Harford	Dec. 1-
Talbot	Jan. 1-
Somerset	Unprotected.
Reedbird, Nov. 1-Sept. 1 (except as follows):	
Cecil	Dec. 25-
Harford	Dec. 1-
Patuxent River	Jan. 1-
Somerset	Unprotected.
Duck (except wood duck), goose, brant, swan, and other wildfowl, Apr. 10-Nov. 1 (except as follows):	
Anne Arundel (on Magothy, Rhode, Severn, and West rivers).	May 1-
Caroline (duck)	Apr.
Cecil, Harford	Special sions[d]
Kent	Apr.
Patuxent River (duck and goose).	Apr. 15-
Somerset (duck)	Apr. 1-
Goose	Apr. 1-
Talbot (wild fowl) on Great Choptank River.	May 1-
Allegany	Unprotected.
Wood or summer duck, Apr. 10-Nov. 1 (except as follows):	
Charles (acorn duck)	Apr. 1-
Dorchester	Jan. 1-
Somerset	Jan 1-
Talbot, Wicomico	Jan. 1-
Worcester	Mar. 1-

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[a] It is not clear whether or not the law protects the wild turkey in these counties.

[b] Except July in Baltimore City, Calvert, Frederick, Howard, and Worcester.

[c] Otherwise as stated in State law.

[d] Wildfowl shooting is also prohibited on Bohemia, Elk, and Sassafras rivers Apr. 1- Tuesdays, Thursdays, and Sundays; on Magothy River, Mondays, Wednesdays, Fridays, or on the Patuxent River, Sundays; on Rhode and West rivers, Tuesdays, Thursdays, Sundays; on Severn River, Tuesdays, Thursdays, Fridays, and Sundays; and on the Susqu- Apr. 1-Nov. 1, and Tuesdays, Thursdays, and Sundays, also Saturdays in November and

NORTH CAROLINA.

Close season for game under county laws—Continued.

Kinds of game.	Close seasons.
r, Feb. 1-Oct. 1 (except as follows):	
Ashe, Chatham, Davidson, Forsyth, Guilford, Montgomery, Moore, Randolph,[b] Richmond, Rockingham, Scotland, Stanly, Stokes, Surry, Watauga, Wilkes, Yadkin.	To Nov. 1, 1910.[a]
Beaufort, Northampton..	Feb. 1-Aug. 15
Bladen,[c] Yancy..........	Dec. 1-Nov. 1.
Brunswick................	Feb. 1-Sept. 1.
Burke, Cleveland, Columbus.[d]	Jan. 1-Oct. 1.
Carteret, Jones...........	Feb. 1-Aug. 1.
Caswell....................	To Feb. 23, 1911.
Cherokee..................	To Feb. 28, 1917.
Craven, Halifax, New Hanover, Warren	Jan. 1-Sept. 1.
Currituck[e]................	Mar. 1-Sept. 20.
Dare (except Hatteras Banks, to Mar. 4, 1908).	Mar. 1-Oct. 15.
Granville, Person, Vance.	Jan. 15-Sept. 1.
Hertford	Oct. 1-Feb. 1.
McDowell	To Feb. 4, 1917.
Madison....................	Jan. 1-Dec. 1.
Mitchell[f]	Nov. 1-Oct. 15.
Nash	Nov. 1-Sept. 1.
Onslow[g]	All the year.
Pamlico....................	Feb. 1-July 15.
Robeson....................	Jan. 1-Nov. 1.
Transylvania...............	Dec. 15-Oct. 15.
Tyrrell[h]..................	Feb. 1-Oct. 15.
Camden, Chowan, Cumberland, Duplin, Edgecombe, Gates, Greene, Harnett, Hyde, Johnston, Lenoir, Martin, Pasquotank, Perquimans, Pitt, Washington, Wayne, Wilson.	Unprotected.
irrel:[b]	
Beaufort, Chowan, Cleveland, Dare (except gray squirrel on Hatteras Banks to Mar. 4, 1908), Gates, Hertford, Lenoir, Mecklenburg, Perquimans, Pitt.	Mar. 1-Nov. 1.
Bertie, Carteret, Craven, Jones, Martin, Pamlico, Pasquotank, Tyrrell.	Mar. 1-Oct. 1.
Edgecombe	Nov. 1-Jan. 15.
Franklin...................	Mar. 1-Sept. 1.
Greene.....................	Feb. 1-Oct. 1.
Madison	Jan. 1-Dec. 1.
Mitchell	Feb. 15-Oct. 1.
Montgomery, Transylvania	Apr. 1-Sept. 1.
Pender.....................	Apr. 1-Oct. 1.
Opossum:[b]	
Alamance, Caswell, Chatham, Durham, Franklin, Graham, Guilford, Halifax, Mecklenburg, Moore, Orange, Pamlico, Wake, Warren.	Feb. 1-Oct. 1.
Clay	Apr. 1-Nov. 1.
Greene.....................	Feb. 1-Oct. 1.
Harnett, Lincoln	Jan. 1-Oct. 1.
McDowell..................	Mar. 1-Oct. 15.
Mitchell	Feb. 15-Oct. 1.
Quail or partridge, Mar. 1-Nov. 1 (except as follows):	
Alexander	Jan. 15-Dec. 1.
Anson[i]	Jan. 20-Nov. 20
Buncombe	Feb. 1-Nov. 14.
Burke, Catawba, Edgecombe, Forsyth, Nash.	Feb. 15-Nov. 15.
Cabarrus, Davidson, Duplin, Franklin, Guilford, Macon, Montgomery, Randolph,[b] [j] Swain, Wilson.	Mar. 1-Nov. 15.
Camden, Cherokee, Clay, Currituck, Davie, Iredell, Pasquotank, Perquimans, Rowan.	Mar. 1-Dec. 1.
Cleveland, Lincoln, Stokes, Surry, Yadkin.	Feb. 1-Dec. 1.
Columbus, Richmond....	Apr. 1-Nov. 1.
Dare, Tyrrell, Vance.....	Mar. 1-Oct. 15.
Durham, Madison........	Feb. 1-Nov. 15.
Gaston	Jan. 15-Nov. 28.[k]
Henderson................	Apr. 1-Nov. 15.
Hyde	Mar. 20-Oct. 15.
Mecklenburg	Jan. 10-Dec. 1.
Mitchell	Feb. 15-Oct. 1.
Northampton	Feb. 1-Nov. 1.
Union.....................	Jan. 15-Dec. 15.
Watauga[l]................	Mar. 1-Sept. 1.
Graham, Onslow.........	Unprotected.
Pheasant:	
Ashe, Chatham, Davidson, Forsyth, Guilford, Montgomery, Moore, Randolph,[b] Richmond, Rockingham, Scotland, Stanly, Stokes, Surry, Watauga, Wilkes, Yadkin.	To Nov. 1, 1910.
Buncombe................	Feb. 1-Nov. 14.
Burke......................	Feb. 15-Nov. 15.
Cherokee	To Feb. 28, 1912.
Edgecombe	Mar. 1-Nov. 15.
Clay	Mar. 1-Dec. 1.
Granville, Macon........	Mar. 1-Nov. 1.
Henderson................	Apr. 1-Nov. 1.
McDowell.................	To Jan. 1, 1912.
Madison	Feb. 1-Nov. 15.
Mitchell	Feb. 15-Oct. 1.
Rowan.....................	Feb. 1-Dec. 1.

eer raised in private preserves may be killed, sold, or used at any time.

ll hunting is prohibited in part of Columbia Township, Randolph County, Jan. 15-Nov. 15, and other part hunting by landowners and tenants is prohibited Mar. 1-Nov. 15.

Carver Creek and White Creek townships.

ithin half mile of Lake Waccamaw.

north side of Poplar Branch Township.

er without horns protected all the year.

New River or within 100 yards thereof.

part of region between Alligator River and county line Feb. 15-Aug. 1.

Lanesboro township only.

Franklinsville Township Jan. 15-Nov. 15.

ose season extends to last Thursday in November.

Cove Creek Township all the year.

NORTH CAROLINA.

Close seasons for game under county laws—Continued.

Kinds of game.	Close seasons.
Pheasant—Continued.	
Rutherford (English, Mongolian).	To Mar. 8, 1918.
Stokes	Feb. 1–Dec. 1.
Swain	Jan. 1–Nov. 20.
Transylvania (English, Mongolian, California, to Nov. 1, 1910).	Mar. 1–Nov. 1.
Watauga	To Jan. 1, 1911.
Wild Turkey, Mar. 1–Nov. 1 (except as follows):	
Anson[a]	Jan. 20–Nov. 20.
Buncombe	Feb. 1–Nov. 14.
Burke	Feb. 15–Nov. 15.
Cabarrus, Cherokee, Davidson, Edgecombe, Guilford, Macon, Wilson.	Mar. 1–Nov. 15.
Clay, Randolph,[b] Rowan, Stokes.	Feb. 1–Dec. 1.
Columbus	Apr. 1–Nov. 1.
Davie	To Mar. 1, 1908.
Henderson	Apr. 1–Nov. 15.
Madison	Feb. 1–Nov. 15.
Mitchell	Feb. 15–Oct. 1.
Northampton	Feb. 1–Nov. 1.
Pamlico	Mar. 1–Oct. 1.
Pender	Feb. 1–Oct. 1.
Richmond	Jan. 1–Oct. 1.
Union	Jan. 15–Dec. 15.
Carteret, Dare, Graham, Onslow, Stanly, Swain, Tyrrell.	Unprotected.
Dove, lark, robin, Mar. 1–Nov. 1[b] (except as follows):	
Buncombe (dove)	Feb. 1–Nov. 14.
Burke	Feb. 15–Nov. 15.
Cabarrus, Cherokee, Edgecombe (except dove, Oct. 1–Aug. 1), Guilford, Macon (dove).	Mar. 1–Nov. 15.
Columbus (dove)	Apr. 1–Nov. 1.
Davidson, Richmond	Apr. 1–Oct. 15.
Davie, Rowan	Mar. 1–Dec. 1.
Halifax (dove)	Feb. 1–Aug. 1.
Henderson	Apr. 1–Nov. 15.
Hyde	Mar. 15–Nov. 1.
Madison (except dove, Feb. 1–Nov. 15)	Jan. 1–Dec. 1.
Mecklenburg	Feb. 1–Nov. 15.
Mitchell	Feb. 15–Oct. 1.
Dove, lark, etc—Continued.	
Northampton (except dove, Feb. 15–Nov. 1)	Feb. 1–No
Stokes	Feb. 1–De
Union	Jan. 15–
Vance	Mar. 15–O
Warren (dove)	Feb. 1–Au
Carteret, Duplin, Graham, Moore, Onslow, Swain, Wilson.	Unprotected
Woodcock:	
Brunswick, New Hanover	Jan. 1–Sept.
Cherokee, Granville, Randolph[b]	Mar. 1–No
Craven, Jones	Feb. 1–No
Edgecombe	Mar. 1–No
Henderson	All the yea
Madison	Jan. 1–De
Mitchell	Feb. 15–Oc
Rowan	Feb. 1–De
Stokes	Feb. 1–Dec.
Snipe:[b]	
Anson[a]	Jan. 20–No
Brunswick, New Hanover	Mar. 1–Sept
Cherokee, Edgecombe	Mar. 1–No
Granville	Mar. 1–No
Halifax, Warren	May 1–F
Madison	Jan. 1–De
Mitchell	Feb. 15–
Marsh hen, curlew, and other shore birds:[b]	
Anson[a]	Jan. 20–
Carteret	Apr. 1–Au
Cherokee, Edgecombe	Mar. 1–
Granville	Mar. 1–
Henderson	All the
Madison	Jan. 1–
Stokes	Feb. 1–De
Wildfowl:[b]	
Anson	Jan. 20–
Beaufort (summer duck)	Feb. 1–
Brunswick, New Hanover	Mar. 1–
Carteret[d]	Apr. 1
Craven, Granville, Jones	Mar. 1–
Currituck[e]	Apr. 1–
Dare[f]	Mar.
Edgecombe, Guilford	Mar. 1–
Henderson	All the
Hyde[g]	
Madison	Jan. 1–
Stokes	Feb. 1–

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[a] In Lanesboro Township only.

[b] All hunting is prohibited in part of Columbia Township, Randolph County, Jan. 15– another part hunting by landowners and tenants is prohibited Mar. 1–Nov. 15.

[c] Ducks only.

[d] Applies to shooting from batteries and sneak boats.

[e] Applies to hunting over decoys. In addition to this close season, Wednesdays, Saturd Sundays are closed for all hunting. Ring shooting is prohibited Apr. 1–Feb. 15.

[f] Applies only to hunting for sale.

[g] Battery shooting prohibited on Wednesdays, Saturdays, and Sundays on Pamlico Sound.

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FARMERS' BULLETIN 309.

Experiment Station Work,

XLIII.

Compiled from the Publications of the Agricultural Experiment Stations.

ICE FOR HOUSEHOLD USE.
CULTURE AND VARIETIES OF ROOT CROPS.
COWPEAS AND SOY BEANS.
SILAGE FROM FROSTED CORN.
COOPERATION IN MARKETING CROPS.
INCUBATION OF EGGS.
CAUSES OF DEATH OF YOUNG CHICKS.
SNOW FOR POULTRY.
ERADICATION OF CATTLE TICKS.
BACTERIA IN CREAM.

SEPTEMBER, 1907.

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- Canebrake Station: *Uniontown;* J. M. Richeson.[b]
- Tuskegee Station: *Tuskegee;* G. W. Carver.[a]

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WASHINGTON—*Pullman:* R. Thatcher.[a]

WEST VIRGINIA—*Morgantown:* J Stewart.[a]

WISCONSIN—*Madison:* H. L. Russ

WYOMING—*Laramie:* J. D. Towar

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[a] Director. [b] Assistant director. [c] Special agent in charge.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce " rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

ICE FOR HOUSEHOLD USE.[b]

The matter of ice and ice supplies has been briefly referred to in a discussion of water for table use in an earlier bulletin of this series.[c]

The purity and wholesomeness of the ice supply has heretofore seemed to be a matter of much less concern to both sanitary engineers and consumers than the quality of the water supply. Yet in view of the increasing uses of ice its purity is rapidly becoming a matter of but slightly less importance than that of water. While the chemical composition and the factors which affect the purity of water have received a large amount of attention by the agricultural experiment stations, little study has been made of ice supplies in station laboratories.

The consensus of opinion is that natural ice formed to a reasonable depth is comparatively pure under usual circumstances, but that it is very likely to be contaminated if it freezes to the full depth of a shallow pond or stream, or if it is flooded, particularly with surface water. The Vermont Experiment Station found that of a small number of samples of pond ice examined all were unfit for household use.

The following extracts from a recent publication of the New York State department of health regarding ice and ice supplies bear directly upon this question:

> In general there are a great many conceivable ways that ice and ice supplies may become infected. The danger from many of these causes of infection may, however, be so remote or so infrequent as to hardly merit notice. There are, however, a few dangers associated with the formation of natural ice and the harvesting of ice supplies, as now generally practiced, which do merit consideration.

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Vermont Sta. Rpt. 1898, p. 177; Mo. Bul. N. Y. Dept. Health, 23 (1907), No. 2, pp. 2-6.

[c] U. S. Dept. Agr., Farmers' Bul. 262, p. 5.

The first of these dangers is the one due to the harvesting of ice from polluted sources. This ice may be taken from ponds or rivers which have been polluted by sewage and may contain the germs of typhoid fever and other diseases.

Secondly, ice may become contaminated during the period and operations harvesting by filth which may have come from infected sources. The han and feet of laborers or the hoofs of horses may be the channels by which infe tion may be transmitted to the ice even after it has been taken from the wa and notwithstanding the purity of the water.

Thirdly, ice may become infected from surface drainage from the adja lands during thaws. The water which has thus flowed over infected fields may have been fertilized or otherwise infected may be carried onto the ice settle and be frozen into it.

Finally, ice may become infected from the exposure and handling incide distribution of it in our cities and even within our homes. This may be the most serious mode of infection, for it leaves the time interval between tion and transmission too short for any counteracting influence of cold exerted.

The opportunities afforded for infection during the distribution of our supply are many. They start with the infection by the icemen in handling ice and include infection from the air of our cities, the dirt and filth gath while the ice is deposited upon pavements and sometimes in street dirty ice broom, the water with which it is washed, and, finally, the han just prior to placing in coolers or ice chests. To be sure, these sources ma largely avoided and wholly eliminated by final and careful washing, but he as in all our daily habits in the preparation of food, sanitary precautions not always observed, and the dangers may often be more real than apparent

Notwithstanding the many possibilities of ice infection, exam tion of the literature of the subject shows that the number of e demics of disease attributable to ice is small. The reason for small mortality from ice infection "of which we have auth record, is due to a series of natural agencies or safeguards * * which tend, by a process of successive elimination, to reduce entirely destroy the bacterial or germ life that may have be originally present in the polluted water or have infected the after its formation, or even after harvesting."

The first safeguard or influence which is active in the reduction of bact life is the well-established phenomenon of subsidence and oxidation upon pended matters, including bacteria in bodies of quiescent or slowly flo water. This action, of course, will effect in the greatest degree the purifi of ice harvested from ponds and lakes. It affects in a large measure, how ice collected from rivers and especially those in which the velocities are enough to admit of formation of ice of sufficient thickness to warrant harve

The second agent in the self-purification of ice is the removal of susp and dissolved matters which is brought about during the action of free It is commonly known as the "filtration process of freezing." and it affects only the suspended matters, such as particles of dirt and bacteria, but chemicals that are in solution. * * *

Of perhaps the greatest influence in the self-purification of ice is the ef of low temperature upon the vitality and life of the bacteria themselves has been found by nearly all observers that bacteria exposed to low tempe tures near the freezing point very soon lose their vitality, and if expos a sufficient length of time are either killed or become so attenuated a

> nonpathogenic, i. e., their vitality has been so lowered that they are unable to be sufficiently revived to produce disease.
>
> This effect of low temperature upon the vitality of bacteria is proportional in a measure to the degree of cold, but of much more importance is the effect of the time of exposure. * * * The few that are not killed after exposure for say one month have become so attenuated as to be unable to produce disease.
>
> There is still another influence depending upon time of exposure that must not be confounded with the phenomenon of cold alone. This is the influence or destruction of pathogenic [or disease producing] bacteria when exposed or disseminated through a body of water. It has been found that without special relation to temperature, pathogenic bacteria are slowly killed when discharged into a body of water. This is probably due partially to the fact that water is not a favorable environment to most species of pathogenic bacteria accustomed to environment in a human being, and partially to the fact that when exposed to the ravages of other water bacteria they are soon destroyed. * * *
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> These facts, while emphasizing the great immunity bestowed by nature, point, however, to the real dangers of ice infection with renewed force. There still remain, for instance, the infection due to handling and distribution; to surface pollution due to the pernicious practice of flooding ice to get a thicker crop; to surface pollution due to rains and melting snow washing pollution from side slopes onto ice that has already formed, and finally to the dangers of artificial ice when this has been manufactured from contaminated water and delivered to consumers before the natural processes of purification have had an opportunity to become active or effective.
>
> It is for the removal of some of these possible or residual dangers, notwithstanding the high efficiency of natural purification, that regulations looking to the conservation of our ice supplies become desirable if not necessary. * * * It needs no proof to show that ice harvested from the vicinity of sewer outlets would be loathsome if not dangerous. In fact, even if there were no danger from such a procedure there would still be an æsthetic objection to organic and other filth associated with polluted waters that make incumbent the forming of laws for the protection of our ice supplies.

With the growth of population and manufacturing industries the pollution of streams, ponds, and lakes is becoming so general as to render it more and more difficult to find unpolluted bodies of water from which to harvest natural ice. It therefore becomes increasingly important to guard against this source of danger to the public health, particularly as the demand for ice is steadily growing and its uses rapidly multiplying.

CULTURE AND VARIETIES OF ROOT CROPS.[a]

As explained in an earlier number of this series,[b] root crops are a valuable feed for stock, especially during the winter when they supplement the rations of grain and other dry feed stuffs. They thrive best in regions having moist and cool weather, but, nevertheless, enough heat and sunshine to promote rapid growth during the growing season. In many sections of the Northern States root crops may be grown with profit, but the fact that their culture is not so generally understood as it should be is probably the reason that they are not grown so extensively in the United States as in Canada and parts of Europe.

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[a] Compiled from New York Cornell Sta. Buls. 243 and 244.

[b] U. S. Dept. Agr., Farmers' Bul. 305, p. 19.

The New York Cornell Station has recently published the resul of investigations as to the best methods of growing mangels, half-sugar mangels, sugar beets, ruta-bagas, kohl-rabi, hybrid turnip turnips, and carrots in order that this information might serve as a guide to those wishing to raise any of these crops under similar co ditions. The culture of these roots is explained as the experience o the station has determined it, and the leading varieties are describ

SEEDS AND SEEDING.

In discussing seeds and seeding it is pointed out that the commercial "seed" of mangels, half-sugar mangels, sugar beets, and carr is really the fruit, of which each individual fruit may contain fr 1 to 7 seeds. The fruit of the carrot, however, bears only one se The commercial seeds of ruta-bagas, turnips, and kohl-rabi a true seeds. Almost all of the seed samples received at the stati contained dust, and in some of them the dust and pieces of st reached 7 per cent of the total weight. The following table give comparison of the different kinds of seed studied at the station.

Comparison of root-crop seeds.

Crop.	Seeds per pound.	Ger
Mangels	32,000 to 185,000	[illegible]
Half-sugar mangels	24,000 to 36,000	[illegible]
Sugar beets	22,000 to 24,000	[illegible]
Ruta-bagas	161,000 to 188,000	[illegible]
Hybrid turnips	183,000 to 266,000	[illegible]
Common turnips	200,000 to 260,000	[illegible]
Kohl-rabies	114,000 to 129,000	[illegible]
Carrots	440,000 to 460,000	[illegible]

In the case of carrots, with a germination power of only 15 cent, the cost of a pound of seed which would grow, based on ordinary price of the seed, or 60 cents per pound, would be $4 pound. This seed was sown at the station, and a good stand w secured, but for each carrot grown over 80 seeds were requir These figures need no comment to show the value and the necessit good seed.

Sowing from May 6 to 9 proved better at the station for all ro than sowing as late as June 12. Planting early in May gener promotes yield, dry matter content, and keeping quality. On loam soil the carrot seed failed to grow when sown one-fourth i deep, while it grew well in sand sown five-eighths inch deep. M gels, half-sugar mangels, and sugar beets were all sown three-four inch deep and all others between one-fourth and one-half inch. A distance of 30 inches between rows is advised, in order to admit of horse culture for a longer period of time than when the rows are put nearer together. With this distance between rows the largest yield per acre may not be realized, but by all possible elimination of hand labor roots are produced at the lowest cost per ton.

GENERAL CULTURAL CONSIDERATIONS.

Mangels were ready for thinning thirty to thirty-five days after sowing, ruta-bagas twenty-five to thirty days, turnips sixteen to twenty-five days, and carrots and parsnips about thirty-five to forty days. Clean culture was given and an application of 100 pounds of nitrate of soda per acre was made when the crop was found to be making insufficient growth. Common turnips, some of the hybrid turnips, and cabbages were used from the beginning of September until November, and the other crops were harvested and stored in October and early in November. Cabbages, common turnips, and some of the early hybrid turnips may be used in September, October, and November, the later hybrid turnips and ruta-bagas in November and December, and mangels and half-sugar mangels the rest of the winter. These crops are all well adapted to feeding cattle and sheep, but ruta-bagas are especially good for hogs, and carrots for feeding horses.

A proper rotation, early sowing, and a uniform stand are regarded as essentials for a high yield. Mangels grown continuously on the same land for four years yielded 9.6 tons of roots, containing 1 ton of dry matter, while on land under rotation they yielded 34 tons of roots and 4 tons of dry matter per acre. From 25,000 to 30,000 plants of mangels, ruta-bagas, and hybrid turnips, and from 40,000 to 60,000 plants of carrots per acre are suggested as proper stands.

Two half-sugar mangels, Vilmorin Half-Sugar Rosy and Carter Half-Sugar, are recommended as suitable stock for breeding purposes. Carter Holborn Elephant, Kangaroo, and Garton Superlative ruta-bagas are comparatively free from fibrous roots and have a uniform and good shape. The Yellow Aberdeen hybrid turnip proved best for early fall use, while Garton Pioneer is later and can be stored as well as ruta-bagas. Of the different varieties of turnips for early fall use, Mammoth Improved Green Globe and White Egg are suggested. Carter 100-ton carrot was the best variety for clay loam soil. Lobberich Agricultural carrot did equally well on clay loam and gravel loam, and Giant Wiltshire and Orange Giant gave good yields on heavy clay loam. The two last mentioned varieties, however, were difficult to harvest because they broke off so readily, thus indicating that they are better adapted to deep friable loams. White Vienna and Carter Model kohl-rabi gave about equally good yields.

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MANGEL-WURZELS.

In a closer consideration of the principal root crops it is pointed out that the five different shapes of mangels grown in this country are the long, half-long, ovoid, tankard, and globe types. In addition to these a long curved type, known as the cow-horn mangel, is grown in Europe. The color of the skin may be white, pink, red, orange, yellow, gold, purple, or black. The flesh, which consists of concentrate rings of firm tissue alternating with rings of softer tissue, is seldom uniform in color. The juice of the softer rings is often colored and may be crimson in the Long Red, golden in the Golden Tankard, or white in the half-sugar mangel and the sugar beet. The long varieties are three to four times as long as their greatest diameter and frequently taper to the crown and the tip of the root. From one-half to two-thirds of the root is below the surface of the ground, which indicates that varieties of this type should be cultivated on deep friable soils worked to a good depth. The half-long varieties are shorter than the long sorts, and they taper from the shoulders to the taproot.

The ovoid form is about two to three times as long as it is broad and tapers to the crown and the tip of the root. The color of the skin is most commonly yellow or orange. About one-half the root may be below ground, and owing to its short length this form is more better fitted for shallow soils than the long forms. The tankard is about two to three times as long as broad and carries its width almost uniformly throughout its entire length. The Golden Tankard, with deep yellow colored flesh, and the Crimson Tankard, with a crimson rose colored skin and with crimson rings in the flesh, are perhaps the best known varieties of this form. Four inches in diameter 10 to 11 inches in length is a common proportion, and generally 5 inches of the root is below the surface. The globe varieties attain a size of from 4 to 7 inches in diameter and are spherical, or more so, in form. This type is particularly well adapted to shallow soils as frequently from two-thirds to four-fifths of the root forms above ground. The Yellow Globe is the variety most commonly grown.

In order that the descriptions of root crops may be better understood, the different parts are briefly defined. The neck or part that bears the leaves may be long, medium, or short. This part should be as small as possible, as it is of little value for feeding purposes. The shoulders, more prominent in some varieties than in others, consist of the upper part of the stem and do not bear leaves. The shoulders and the neck together constitute the crown, which is removed from sugar beets before using them for the manufacture of sugar. The stem or hypocotyl is the thick fleshy part between the neck and the taproot or primary root. It is rich in nutrients and varies in length in different varieties. The primary root appears as a continuation of the stem. It should terminate in a single small taproot, as secondary roots prongs, or forks are undesirable, not only increasing the cost of harvesting, but also indicating a coarse and fibrous nature. Well-formed roots are described as smooth, while those lacking the proper shape are referred to as forked or rough. The two depressions running lengthwise down the primary root on opposite sides are known as the dimples. The lateral roots should be fine, fibrous, and fairly abundant, and spring from the dimples. This fibrous root system breaks off in harvesting.

While mangels may be grown on almost all productive soils, deep loams are considered best and are necessary for the production of heavy yields of the long varieties. Mangels and sugar beets need considerable sunshine for the development of the root and the elaboration of sugar. With a good supply of moisture in the soil after the plants have become established they will grow in a warm, dry climate and withstand drought far better than most other crops. In the rotation mangels may be grown between two grain crops or after another intertilled crop which has been heavily manured, as cabbages. Good success is also secured in growing them after clover which has been down for a year, and as they are not harvested until late in the fall, the grain crops best suited to succeed them are oats and corn. If oats follow, the tops should be spread uniformly over the land and plowed under in the fall, because the leaves are a valuable manure, and if left unspread the grain crop will be uneven.

In preparing the soil for mangels it is advised to plow deeply in the fall and to cross-plow or to give a deep disk harrowing in the spring. Ten to 12 tons per acre of barnyard manure should be applied previous to plowing, and this may be supplemented in the spring with fertilizers. The seed bed should be put into fine condition with disk and spike-tooth harrow, and previous to the last two harrowings from 240 to 280 pounds of acid phosphate, 100 to 120 pounds of nitrate of soda, and 100 to 120 pounds of muriate of potash should be mixed together and applied immediately. This treatment will stimulate the young plants into vigorous growth. In some cases 400 to 500 pounds of salt per acre are applied. If the land needs lime, the use of 1,500 to 2,000 pounds per acre will often be found profitable.

Owing to the smallness of the seed it is easy to sow it too deep. From 6 to 8 pounds of good seed are required per acre, and the sowing may be done with a grain drill. A 7-inch 11-hoe drill may be used to sow the seed in either 28 or 35-inch rows. In order to facilitate the use of a 2-horse cultivator the rows should not be less than 30 inches apart. As soon as the plants have four leaves all the plants except little bunches every 6, 8, or 10 inches apart are chopped out with a hoe 5 or 6 inches wide, and after this has been done the remaining plants are thinned to but one plant every 6 to 10 inches. The globes and tankards require rather a greater width in the row than the long varieties. The bunching and thinning must be done at this stage, for if done later the development of the plants is checked. As soon as the rows can be seen, shallow cultivation is given to keep the land at all times free from weeds and from a hard or crusted surface. If the plants appear stunted when they are thinned, a top dressing of [illegible] pounds of nitrate of soda per acre mixed with 50 pounds of acid phosphate, or with salt or sand to give it bulk, may be used with pro- The mangels should be harvested before severe frosts occur and ma- be taken up at any time when the outer leaves have withered. T- roots should be pulled up with as little injury as possible and the to- twisted off. If stored in a root cellar, the place should be dry and well ventilated. The average yield is generally from 16 to 29 [illegible] although at the station during the past three years several vari- have yielded at the rate of 40 tons per acre. The average yield of dr- matter per acre during the past three years was between 2.4 and tons. In the case of sugar beets 20 tons of beets contained about 4 4.5 tons of dry matter, while the yields of half-sugar mangels ra- between the yields of mangels and sugar beets. The amount of dr matter in mangels usually varies between 7 and 14 per cent. In 1- on the University farm, the dry matter varied between 9.56 and 1- per cent in nine varieties. About half of the dry matter is sugar, percentage often varying between 3 and 8 per cent. It is pointed o- that the average composition of the mangel to-day is practically th- same as it was fifty years ago, while the sugar beet has been increa- 50 per cent in its value for sugar production during the past fi- years.

TURNIPS.

The turnip also consists of a thickened stem and root. The be- known types are the common turnip (*Brassica rapa*), the hybrid t- nip, and the ruta-baga, Swedish turnip, or Swede (*Brassica camp- tris* or *Brassica rutabaga*). The common turnip and the ruta-ba- are thought by some to be of distinct primary origin, while hybr- turnips are said to be a cross between these two. In the turnip the color of the leaves is a grass green, while the ruta-baga has les- of bluish green or covered with a bluish white bloom. The tur- finishes its growth in from sixty to ninety days, while the ruta-ba- requires from ninety to one hundred and eighty days. The fle- the turnip is soft, usually white to yellow, more often white, wh- that of the ruta-baga is firmer, white, yellow, or orange, but n- often yellow. Turnip seed is small, only 2 to 3 pounds being - per acre, while of the larger and darker ruta-baga seed 4 to 5 pou- are required.

Turnips are classified commercially according to their shape, form of the upper part of the root, color of the upper part of the root, and color of the flesh. The principal shapes are long, tankard, round or globe, and flat, but there is considerable variation between these different forms. Some taper toward the tap root, while others are fairly uniform in width. The long type, three or more times as long as broad, generally tapers toward the tap root. The tankard form corresponds to the tankard form of the mangel. A large proportion of the root of this type is above ground and the part underground tapers abruptly toward the tap root. All roots nearly spherical belong to the round or globe form and the flat-shaped turnips are greater in width than in length. The round or globe turnips tend to grow deep in the soil and are better suited to deeper soils than the tankard or flat types. The roots are flat-topped or round-topped, according to the shape of the upper part of the root and the character of the shoulders. The crown should be convex to avoid holding water. The roots are called white, yellow, green, bronze, purple, or red tops, and graystones, according to the color of the part of the root exposed to the light. The roots known as graystones have the upper part mottled with transverse green and purple streaks. The flesh of turnips is generally either white or yellow. The yellow flesh varieties of common turnips are considered of superior quality, and most of the hybrid turnips introduced on account of their superior merit have yellow flesh. The crown should be single; that is, only one shoot or neck should arise from it, as roots with multiple crowns or those having several shoots are generally coarser, more fibrous, and considered of lower feeding value.

The best soils for this crop are free-working lands, rich in organic matter and in good tilth. Common turnips will do better on lighter loams than ruta-bagas, and these will give a better yield than turnips upon heavy to medium loams. Climate is apparently of more importance than soil for this crop. A damp and rather dull climate, with a well-distributed rainfall throughout the growing season, seems to be best. To prepare the land it is recommended that an application of about 10 tons of barnyard manure per acre be plowed under in fall and the land be put in good tilth the next spring. Lime slaked to a very fine powder may be applied at the rate of 1,000 pounds of quicklime per acre and harrowed in with 400 to 600 pounds of acid phosphate and 50 pounds of nitrate of soda. This application must be well incorporated with the soil before sowing and the seed bed made as fine as possible. From 2½ to 5 pounds of seed are usually sown in the case of ruta-bagas and hybrid turnips and from 2 to 4 pounds, or an average of 3 pounds, per acre in the case of common turnips when the rows are 27 to 30 inches apart. It was found at the station that ruta-bagas and Garton Pioneer hybrid turnips, wh sown early, lost in quality by the production of long necks. It considered best to plant in rows 30 inches apart, which will admit easy cultivation, and to place the plants 7 to 8 inches apart in t row. With this rate of planting an acre will contain about 28,0 plants. The cultivation consists in keeping the land free from weed by means of frequent, shallow tillage. As the crop grows quickl only three or four cultivations can be given, with intervals of seven t ten days, before the leaves meet in the rows. A top dressing of pounds of nitrate of soda is sometimes very advantageous. In 190 the station secured from 20 to 25 tons per acre from such varieti as the Improved Green Globe and the Carter Mammoth. In 19 White Egg gave the largest yield. During two years hybrid turnip sown on May 11 yielded at the rate of 23 tons, while those sow June 12 yielded only about 14 tons per acre. Garton Pioneer showe considerable resistance to soft rot, being the only one not attack and yielding for the two years at the rate of nearly 28 tons per ac

The average yield of ruta-bagas from the early sowing for tw years was at the rate of 21 tons. The common turnips are harves as soon as they are large enough and often used for feed in the f The hybrid turnips may be used a little later and may even be stor Garton Pioneer being a good variety for this purpose. Ruta-bag are usually stored after mangels, but before serious frost has occurr

KOHL-RABI.

Kohl-rabi (*Brassica caulorapa*) is grown for its thickened st instead of for its leaves. The crop succeeds wherever ruta-ba succeed, the cultural treatment of the crop being the same. The is not so subject to disease as ruta-bagas, withstands drought be can be grown on heavier soils, and thrives well on muck land. further advantages are that it stands well out of the ground and be readily pastured by sheep; that it does not seem to cause tai milk when fed to dairy cows, and that it is also better than the r baga in withstanding frosts and developing in warm climates. leaves are as valuable for feed as the stem. Among the well-kn varieties are the White and Purple Vienna, Short-top White, Gol and Carter Model.

CARROTS.

The carrot, like the mangel and turnip, is made up of thick stem and root, the proportions of the two parts varying in diff varieties. The carrot is composed of a well-defined outer usually red or scarlet in the red varieties, and an inner layer or generally yellow or dull white. The outer layer is considered of higher feeding value than the pith; hence those containing smallest percentage of core should always be selected. This crop requires deep, well-pulverized, sandy loam soil, fitted and cultivated the same as for mangels. The manure should be applied to the previous crop or else be well rotted before being plowed under. The seed germinates very slowly and from 6 to 7 pounds should be sown per acre, although if it is of good germination power 4 or 5 pounds is sufficient. Carrots should be sown in rows about 30 inches apart and the plants left about 3 inches apart in the rows. This gives from 55,000 to 60,000 plants per acre. The crop is usually harvested before severe frost sets in and stored as other roots. At the station the yields varied from 7 to 25 tons per acre, although it is stated that much higher yields are sometimes reported. The leaves of carrots appear to be of higher feeding value than the leaves of mangels or ruta-bagas. Carrots are considered of high value for all classes of stock, but especially of great value for feeding horses.

COWPEAS AND SOY BEANS.[a]

The great importance of cowpeas and soy beans to our agriculture is more and more recognized, and the culture of these crops is spreading from year to year, not only in all sections of the Southern States, but even to unexpected northern latitudes. The two crops were recently grown in comparison by the Indiana and Oklahoma experiment stations, and several points worthy of attention were brought out for the benefit of growers. The plants are similar in many respects, while they differ in others, and a comparison of their characteristics leads to a better knowledge of their adaptations and value.

PLACE IN ROTATION.

On most, if not all, farms where cowpeas and soy beans can be grown successfully either one or both can profitably be given a permanent place in the crop rotation. In some localities both crops succeed well, but the one is perhaps better known than the other. For this reason a larger acreage may be devoted to it. In Oklahoma, for instance, where the cowpea is quite extensively grown, the soy bean has not come into such general use as a forage or a grain crop, although it is considered by many a good substitute for the cowpea in the rotation. Both the cowpea and soy bean are well adapted to preceding a crop of wheat. When planted early and well cultivated, it is possible to harvest the crops in August in Oklahoma, leaving ample time to prepare the land for winter wheat.

For the corn and wheat producing sections of the State a three-year rotation, consisting of corn the first, oats the second, and wheat, followed by either cowpeas or soy beans, the third year, is recommended.

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[a] Compiled from Indiana Sta. Bul. 120; Oklahoma Sta. [illegible]

For a more extended rotation the following succession of crops is suggested: Corn, Kafir corn, cotton, oats, and wheat, followed by cowpeas or soy beans the same year. In the sections of the State where broom corn is grown a rotation consisting of broom corn the first year, cowpeas or soy beans the second, and durum wheat the third year, is considered profitable. Many farmers sow cowpeas between the corn rows at the last cultivation, and this practice makes it possible to use the crop twice in a three-year rotation, as, for instance, when oats followed by cowpeas are grown the first year, cotton the second, and corn the third. In addition to increasing the fertility of the soil through their power of using the free nitrogen of the air and storing a considerable quantity of it in their roots, both crops have a beneficial effect upon the physical condition of the soil by making it loose and mellow.

SOIL AND MANURING.

Although cowpeas and soy beans, like other leguminous crops, increase soil fertility, they are not successful on thin and badly worn lands. The influence of barnyard manure on the two crops was shown in an experiment made by the Oklahoma Station. Two crop rotations, one including the cowpea and the other the soy bean, were grown on manured and unmanured ground. In the first corn, oats, wheat, and cowpeas in the order given occupied the soil during a period of three years. Cowpeas were grown in 1902 and 1905, but the latest crop had a poor stand and the yields were low. The plats which had been manured at varying intervals gave an average yield of 3.23 bushels of grain and 0.35 ton of straw per acre, while the unmanured plats yielded 2.88 bushels of grain and 0.29 ton of straw. The second rotation, consisting of castor beans, Kafir corn, cotton, oats, wheat, and soy beans, was completed in five years, necessitating the removal of both wheat and soy beans the last year. The manured plats in this experiment received 14 tons of manure per acre in 1902, but no manurial treatment was given afterwards. In 1904, after the wheat was harvested, the land was disked with a disk harrow several times, and 30 pounds of soy bean seed per acre was put in with a disk drill July 12. This crop required seventy-nine days to mature, and was harvested October 1. The unmanured land produced on an average 11.6 bushels of grain and 0.68 ton of straw and the manured 17.6 bushels of grain and 1.02 tons of straw per acre.

In 1904 cowpeas and soy beans were compared in general farm work on bottom and upland soil. The bottom land was seeded May 5 and the upland June 30. In both trials cowpeas gave much the heavier yields of cured hay per acre. This has also been the experience of the Indiana Station, where the cowpea produced about twice as much hay and not half as much grain as the soy bean. Heavy rains interfered with the crops on the bottom land, and hence the late planting on the upland soil gave the better results, especially in grain production. The soy bean stood the excessively moist conditions better than the cowpea. Both crops are also quite drought resistant, the power of endurance being a little greater in the soy beans than in the cowpea.

PLANTING.

Both crops are generally drilled in rows 24 to 36 inches apart. At the Indiana Station the common wheat drill was found the most convenient and most satisfactory machine for doing this work. It is recommended that for the medium-sized varieties the drill be set at 2 bushels per acre on the wheat scale, and using the first, fifth, and ninth holes, thus making the drills 32 inches apart for soy beans, or the first, fourth, seventh, and tenth holes, making the drills 24 inches apart for cowpeas. The 32-inch drills require about 23 pounds of seed per acre and the 24-inch drills about 30 pounds. For the smaller seeds the drills should be set at about 2 pecks less and for the larger seeds at about 10 or 12 pecks per acre on the wheat scale. In 1904 at the Oklahoma Station soy beans in rows 24 inches apart gave an average yield of 8.6 bushels of grain and 0.77 ton of straw per acre, while a 32-inch planting produced 10 bushels of seed and 0.89 ton of straw. The average results for three years of experiments in methods of planting soy beans for seed production at the Indiana Station show that drills 32 inches apart and cultivated produced the best yield. Tests at different stations indicate that both crops are sensitive to crowding. In this particular experiment at the Indiana Station 32-inch drills with cultivation gave an average yield of 21.3 bushels per acre, 24-inch drills with cultivation 20.4 bushels, 8-inch drills with no cultivation 15.6 bushels, and broadcasted plats 10.7 bushels.

HARVESTING.

Directions for harvesting given by the Indiana Station state that when the soy bean is desired for hay the crop should be cut when the pods are about half filled and dried and then handled much as pea-vine hay. It was found, however, that the soy bean is not to be recommended for haymaking, being more distinctively a grain crop, and that the cowpea is much more satisfactory for this purpose. When grown for the grain the soy bean should be harvested as soon as three-fourths of the leaves have fallen and the majority of the pods have attained a brownish color. The crop must not be allowed to ripen too thoroughly, as the pods then have a tendency to burst open and to scatter their seeds. The Medium Green, the Very Dwarf

Brown, and the Ogema soy bean were found to be particularly give to shattering, while the Ito San, Early Brown, and Medium Earl Yellow were less liable to loss in this way.

The cowpea should be cut for hay or for soiling when the first po begin to ripen. This subject is discussed in a previous bulletin o this series.[a]

THRESHING.

The Oklahoma Station found that the use of a machine for thre ing the cowpeas, even after blank concaves had been put in and s of the teeth of the cylinder removed and the speed of the mach reduced, was not very successful, a large percentage of the grain bei broken and spoiled for planting. It is suggested that threshing t seed with a flail will give better results and will cost approxima from 6 to 8 cents per bushel as compared with 4 to 5 cents for mac threshing. The soy bean is not so brittle as the cowpea and can readily threshed with the machine, provided the precautions abo mentioned are taken.

VARIETIES.

With reference to varieties, the Oklahoma Station states the Medium Green, Early White, Ito San, Medium Yellow, and Bl soy bean varieties ripen early and mature even in sections where t growing period is much shorter than in Oklahoma. Of the differ varieties of soy beans tested at the Indiana Station, the most p ductive varieties were Medium Green, with an average yield for f years of 22.2 bushels; Early Brown, with 21.5 bushels; Ito San, w 21 bushels, and Medium Early Yellow, with 20.2 bushels per a Tests of several varieties of cowpeas made by this station showed t the California Blackeye ranked first in earliness, requiring only o hundred and twelve days to ripen as compared with one hundred a forty-two days for other sorts in the test. The White Era and Wh poorwill gave the largest yields of grain and the Iron was the gr producer of forage. A number of varieties of cowpeas were gro for two years at the Indiana Station, and of these the leading va ties with their average yields of hay per acre annually were as follo Clay, 7,600 pounds; Iron, 7,400 pounds; Warren, 6,500 pounds, a New Era, 6,450 pounds.

RELATION TO SOIL FERTILITY.

The complaint is sometimes made that the soy bean does not enr the soil to the same extent as does the culture of the cowpea. Jud ing from the chemical composition of the two crops it seems pos that when both crops are removed from the soil the soy bean carries away a greater quantity of fertility because the grain is so much richer in nitrogen than the grain of the cowpea. If, however, both crops are used for green manuring their chemical composition can not produce a wide difference in soil improvement. The higher nitrogen content of the soy bean seed is offset by heavier yields of green material in case of the cowpea.

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[a] U. S. Dept. Agr., Farmers' Bul. 222.

SILAGE FROM FROSTED CORN.[a]

In view of the difference of opinion among farmers as to whether corn is seriously damaged for silage making by frosting, the Vermont Experiment Station undertook experiments in which different sections of the same field of corn were ensiled in unfrosted condition and after different degrees of frosting.

A little more than half of it was cut into the silo on October 7, immature and just barely touched by an extremely light frost. A hard frost seemed imminent that night, but did not occur. Indeed, the first hard frost was delayed two weeks, occuring on the night of October 21. Half of the remainder was cut on that date prior to the frost, mature, ears glazed; the remainder two days later, on Monday, mature, ears glazed, hard frosted or even frozen, with leaves badly whitened.

The feeding value of the different lots oı silage was determined by feeding experiments with 21 milch cows for from fifteen to twenty-five weeks. It was found that—

(1) In every case more dry matter was eaten when the mature silage ration was fed, as was to have been expected; (2) the quality of the milk made when the silage from the frozen corn was fed was depressed slightly; (3) the total solid and fat yields were slightly depressed when the ration containing the frozen corn silage was fed; and (4) the products per unit of consumption were depressed when the more mature silages were fed, owing to the greater consumption but smaller production.

The general outcome of the experiments, therefore, was that "the effect of frosting corn, and yet more of freezing it, appears very slightly to have been to depress its feeding value when made into silage."

In view, however, of the fact that from 6 to 15 per cent more total dry matter was harvested as a result of the two weeks' longer growth of the crop, and in view of the presumption that the proportion of digestible dry matter was similarly augmented, a 1 per cent depression resulting from the feeding of frozen silage is a negligible quantity. No ill result on the butter product was observed. It is reported that silage made from frozen corn keeps well in a good silo. It would appear, therefore, that the testimony of this trial is, on the whole, in favor of running frost risks to gain a greater maturation.

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[a] Compiled from Vermont Sta. Bul. 129, p. 132.

COOPERATION IN MARKETING FRUIT AND TRUCK CROPS.[a]

The cooperative idea among fruit and truck growers, having passed the experimental stage, has become an important factor in present-day marketing. Scarcely any well-developed horticultural sections are without their associations in one form or other. New fruit and truck regions are being constantly developed, however, and a brief study of cooperative methods may be of value. The benefits to be derived from such organizations are many. Small producers can make combined shipments in car lots, which is now considered the economic unit of shipment. Organizations, through the volume of thèir business, can secure minimum transportation rates. They can afford to maintain daily telegraphic communications with all of the important markets and are thereby enabled to divert cars already en route to places where the demand is greatest. Growers are advised when to hold and when to ship. Uniform grades and packs are secured. Organizations are in a position to know the actual supply of their respective communities; hence managers, working in harmony, can regulate prices to a considerable extent. Through the association the members can procure packing material, fruit-pickers' baskets, spraying materials, and pumps, potato bags, etc., at a great reduced cost. Successful associations require choice products. By an interchange of ideas and experience members are in position to eliminate unprofitable varieties of fruits or vegetables from the community and to develop thorough and economic systems of cultivation. These and many other advantages might be noted.

Cooperative associations have developed rapidly in the West. Over thirty fruit and produce organizations of various kinds are now doing business in Colorado. In a recent publication of the Colorado Station W. Paddock describes the workings of these associations, which in general way are similar to those of other sections.

> There are two methods of packing and grading fruit; in one instance association does all the packing, the growers delivering the fruit to the packing house just as it is taken from the trees. Here the packers, under the direction of a superintendent, sort the fruit into the various grades, and at the same time pack it into boxes or crates. Should there be any culls they are returned to the grower and are at his disposal.
>
> Each grower is given a number, which is used to designate his fruit throughout the season. As each box is packed it is marked with his number and its grade. When the boxes are loaded into the cars the number of boxes, the varieties, and the various grades which belong to any grower are kept account of and duly recorded. In this way the price for each box of fruit in any car is easily determined.

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[a] Compiled from Colorado Sta. Bul. 122; Maryland Sta. Bul. 116; Oregon Sta. Bul. 94. See also Transactions Wisconsin State Hort. Soc. 1907; Canada Dept. Agr., Dairy, and Cold Storage Comr. Bul. 18.

But where there is a very large amount of fruit to be handled it is impossible for the association to do the packing, consequently the growers assume this work. With this arrangement the association employs an inspector, whose duty it is to inspect each load as it is delivered. This he does by opening the boxes on the side in the case of apples, when a good estimate of the contents may be made. If the pack is satisfactory not more than two boxes may be opened. If unsatisfactory, several may be examined, and if all run under the inspector's standard. the entire load must either be placed in a lower grade or else be repacked.

It will be seen that a great deal depends on the inspector, and that it is a difficult position to fill. Upon him depends the reputation of the association, so he must be entirely free to do the work as he sees fit.

Each man's fruit is kept track of by numbers, as in the former case.

The association charges a commission on all sales, usually 5 per cent, to defray expenses. Then, in case the packing is done by the association, an additional charge is made to cover the cost of the box and packing. Any surplus is, of course, distributed as premiums. Any fruit grower may become a member of the association so long as there is stock for sale, and the owner of one share is entitled to all of its privileges. The number of shares one individual may own is limited.

The growers are generally asked and, in many instances, required to furnish an estimate of their crop. In the smaller associations the manager sometimes secures this information by visiting the orchards in person. This estimate is made early in the fall, or not until damage by worms and other causes is practically over and the crop is secure. With this knowledge in hand, the manager can enter into contracts for delivering certain amounts of various varieties or grades.

The system of selling has been radically changed within the past few years. Formerly practically all of the fruit was consigned to commission men, who, as a class, it may be truthfully said, are inclined to do the best they can by their constituents. But too often the experience has been otherwise. Not infrequently has it happened that shipments consigned to a distant city have been reported as not being up to grade, or not in good condition, so the market price could not be realized. In such cases, though the manager may be certain that his fruit is as he represented, he is often unable to help himself, so must take what he can get. But of late years the plan of selling f. o. b. is being practiced more and more, and this is largely due to the organized efforts of the associations. Consignments are only made to well-known firms, and much of this fruit is sold at auction.

But even with this arrangement difficulties arise, so in order to protect themselves the larger associations have an agent at the more important distributing points. It is the duty of the agent, or broker, to inspect all cars which come into his territory, as near the destination as possible, and thus protect the association from dishonest buyers. He also is on hand to adjust the differences which arise when the fruit actually reaches the buyer in poor condition.

Express shipments are only made to comparatively near-by points, and with such shipments the growers receive exactly what the fruit brings, less the expressage and the association's commission. It is usually the early fruits that are expressed, but prohibitive rates prevent any very large amount of business being done in this way.

Such associations often fail in their purpose. The prime causes of failure are well summed up by Waugh,[a] on the following page:

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[a] Fruit harvesting, storing, marketing.

> All classes of farmers are constitutionally and proverbally distrustf other people and of one another. In a fruit association there arise (such experience) the most inveterate jealousies. Each man thinks he is furn a better grade of fruit than his neighbor, though all share alike in the p Each one fears the other will reap some special advantage somehow. I ticular, the appointment of managers, superintendents, supervisors of gr shipping agents, and all other officials of the company offers a sufficient tunity for the elaboration of all sorts of neighborhood quarrels. Each thinks he ought to be manager, and when one man is finally chosen he is suspected of all sorts of favoritism. In any case, he is apt to be hamper his business relations by committees, boards of directors, and various kin red-tape and foolishness. Often he has to consult a committee before any important action. * * *
>
> Another difficulty which arises from the same cause is that subscrib such an association never want to pay a manager's wages. Two or dollars a day is considered good pay. Yet such a man is compelled at tim handle thousands of dollars' worth of business. The position is such ordinary business life would command a salary of $5,000 a year or more

Where such conditions exist there is little chance of success. T may be avoided to a great extent if inexperienced shippers will the size of their organization until the minor details connected with have been thrashed out. A few selected growers are suff to demonstrate to the community the advantages of cooperation a healthy expansion will soon take place. When the volu business is sufficient to warrant such action, the management be turned over to a man who is especially equipped with a know of the details of marketing, and who has no crop interest own. He should receive the confidence of the members and be a chance to work out his own ideas. The manager's salary be adequate for the work and responsibility involved. It is times the custom to give him a percentage on the total amo business transacted. Well-established associations, however afford to pay a good manager a straight salary and thus feel certain of retaining his services from year to year. The Co bulletin, previously referred to, contains a report of the Junction Fruit Growers' Association, which "is the oldest doing the largest business of any in the State."

> This association was started in 1891, when a few growers combin appointed one of their number salesman of their fruit for the seaso arrangement continued with varying degrees of success up to 1897. became apparent that the increased business, if no other cause, would tate employing a manager by the year, who should devote his entire the association. Accordingly, this was done, and the business has in year by year, as shown below. That the majority of the stockholders isfied with the workings of the association is proven by their loyalty the fact that the capital stock has recently been increased to $100,00 purpose of accommodating the increasing number of members.[a]

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[a] Number of stockholders January, 1907, was 666; number of shares sold to January, 1907, was 14,169.

The Grand Junction Fruit Growers' Association—Growth of business.

Year.	Paid growers.	Total business.	Cars shipped.	Year.	Paid growers.	Total business.	Cars shipped.
1897	$54,085.00	$88,987.00	167	1902	$195,975.15	$287,887.15	618
1898	21,785.00	43,750.00	89	1903	247,188.45	339,805.41	682
1899	21,346.00	56,591.00	82	1904	437,154.33	557,291.11	1,282
1900	68,323.00	114,590.00	202	1905	475,763.00	608,408.80	797
1901	98,972.90	158,380.00	256	1906	555,813.44	814,278.62	1,036

Cooperative associations are especially well developed in the Pacific coast region. According to C. I. Lewis, of the Oregon Station, the Hood River Apple Growers' Union has met with great success.

The Hood River organization now has a membership of over 100 and controls approximately 90 per cent of the fruit of the valley. In four years it has been able to raise the price from 85 cents to $3.15 for the best grade of Spitzenbergs, and $2.50 for the best Yellow Newtowns. The prices range somewhat as regards size and quality. As an experiment this past fall the association sent 9 carloads of fall apples to England. These apples were selling here at approximately 85 cents a box. After all expenses were paid they netted the Hood River growers $1.32 per box.

As a type of a well organized and managed association in the East, W. N. Hutt, of the Maryland Station, gives the following description of the Peninsula Produce Exchange of the eastern shore of Maryland:

This exchange operates along the lines of the New York, Philadelphia and Norfolk and the Baltimore, Chesapeake and Atlantic railroads. It has 25 local shipping points at each of which is an agent who inspects and brands the grade of produce, and reports to the head office at Olney the amounts and grades of fruit and truck received. The general manager in the head office is in touch by wire with prices in all the large markets, and as soon as the daily reports of receipts and grades are wired in from his local agents is in a position to make his sales and place his consignments where the demand is greatest. The exchange spends over $10,000 annually in telegrams regarding crops, markets, and prices. The capital stock of the exchange was reported in 1905 at $31,000. This was owned by the 2,500 farmers who sell through the exchange. In 1905 a dividend of 7 per cent was declared and in 1906 a 10 per cent dividend. In addition to this a surplus was laid by for emergencies. The exchange forwards annually thousands of cars of both sweet and Irish potatoes in addition to other truck and fruit. It is reported as doing an annual business in the neighborhood of $2,000,000.

Instances of successful organizations might be noted from every prominent horticultural region in the United States. The above examples, however, are sufficient to demonstrate the possibilities of such institutions. The details of organization will vary more or less in their solution, depending greatly on the nature of the region and crops to be handled and the volume of business conducted. In the publications of the Oregon and Colorado stations herein mentioned the text is given of the articles of incorporation and by-laws of certain associations, together with instructions to growers and packers. Such information can usually be procured in printed form from any well-established organization.

EVAPORATION OF EGGS AND OTHER FACTORS WHICH AFFEC INCUBATION.[a]

During incubation the egg loses water by evaporation, and t amount lost has an effect upon the number of eggs which hat C. A. Whiting, who recently studied this question of evapora found that during incubation a fertile egg lost a little over 20 p cent in weight, while a sterile egg receiving like treatment lost per cent. Another fertile egg, weighing 2.22 ounces, lost during in bation 21.64 per cent in weight. The chick hatched from the weighed 1.55 ounces, or 29.65 per cent less than the egg before bation. A fertile egg shaken vigorously to destroy the germ lo per cent during incubation.

In tests carried on at the Ontario Agricultural College and Exp mental Farm to secure data regarding the evaporation of eggs u different conditions with reference to the number which hatche was found that when eggs were hatched by hens in nests in the the average evaporation of those which hatched was 10.9 per The same figures were obtained with eggs hatched in a nest lined rubber cloth and placed inside a building, and a slightly higher 11.9 per cent, with nests containing a layer of moist earth and inside a building. The highest evaporation of eggs which hat 15.15 per cent, was observed with nests containing chaff and inside a building. In the case of incubators the average perce of evaporation of eggs that hatched ranged, under different co tions, from 9.1 to 16.3 per cent. Considering both natural and a cial incubation, the range was from 5.9 to 27 per cent. With out nests 87 per cent of the fertile eggs hatched; with indoor nests taining moist earth, 85 per cent; with indoor nests made of cha per cent, and with an indoor nest lined with rubber cloth 100 per In the incubator tests 65 to 76 per cent of the fertile eggs hat From the recorded data, W. R. Graham, who conducted the inve tions, believes that the best results will be obtained when the eva tion is controlled so that it is about that of eggs hatched by hens nests out of doors on the ground.

Tests made at the University of St. Louis, by A. C. Eycleshy showed that during natural incubation the loss by evaporation w per cent of the original weight of the egg and that this loss cou lessened to 9 per cent and still the egg would give a healthy When increased, experimentally, to 20 per cent, perfect chick o obtained. These results are, in general, much the same as those ained at the Ontario Experimental Farm, and if average values considered it seems fair to conclude as did Eycleshymer that in ificial incubation "the moisture in the incubator should be so trolled that it will allow the evaporation of about 13 per cent of original egg."

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[a] Compiled from Bul. South. Cal. Acad. Sci., 5 (1906), No. 3, p. 59; Ann Ontario Agr. Col. and Expt. Farm, 32 (1906), p. 202; Biol. Bul. Mar Bio Woods Hole, 12 (1907), No. 6, p. 360. See also U. S. Dept. Agr., Farmer 186, p. 28; 281, p. 24.

n the experiments at St. Louis University the effect of a number of er conditions on the incubation of eggs was also studied.

s regards the turning of eggs, Eycleshymer points out that—

> he hen turns the egg in two ways. If a sitting hen be watched as she returns n feeding to sitting, it will be seen that she moves her body rapidly from side side. Whether the object be to turn the eggs is uncertain. Probably the t object is to bring the surface of the body in the closest possible contact h the growing embryos. Accidentally or purposely, she also turns the eggs. s is not only true of the hen returning from feeding, but also when on the t, for she is frequently observed moving about and settling down with the e characteristic lateral movements. Sometimes there are so many eggs in nest or they are so widely scattered that the hen fails to properly cover n. When such conditions occur, the hen invariably uses her beak to bring outlying eggs in contact with her body. Not only does she frequently thus the eggs, but also she very often reaches beneath her body and turns the lying near the center of the nest. Why she does this, is a question which its an answer.

I. F. Prince, who studied this question at the Agricultural College Cornell University,[a] with a number of hens, found that in every ance the eggs were moved every day and did not remain in the e part of the nest for more than three days. "The thorough manin which the hen turns the eggs may well furnish us a clue to the t natural and proper treatment of the eggs when under the artil conditions of the incubator."

ycleshymer's experiments with an incubator showed that the best ilts were obtained when eggs were turned frequently, at least five es. The embryos in unturned eggs not infrequently die, the prinl cause of death being attributed to the allantois, a membranous essential to the normal development of the embryo, growing fast he yolk, which causes the rupture of the membrane inclosing volk and allows it to escape, so that it can not be taken into the y of the embryo. When the eggs are turned it is probable that position of the allantois is shifted and thus adhesion to the yolk revented. "It should be remarked that during the early days of bation it is also necessary to turn the eggs frequently; otherwise, embryo grows fast to the shell membrane."

a study of the effect of temperature a great many observations made of the temperature of the eggs directly under the hen, of the hen's body, and of the eggs during incubation. Special therm eters were used and precautions taken to secure accuracy. Un natural conditions, in the author's opinion, his observations show th the proper temperature of eggs during the first week is about 100 101° F. for the second week, and 102–103° F. for the final week. the case of artificial incubation the experimental data reported le the conclusion that the most favorable temperature within the chamber is close to 102–103° F., the first half of the incubating pe and 103–104° F. for the latter half.

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[a] Cornell Countryman, 3 (1906), p. 139.

In any consideration of temperature, the fact must be kept in mind th the chick grows it gives off more and more heat, so that if an incubator o egg capacity were entirely without artificial heating, the temperature wo much higher than that of the surrounding atmosphere; it consequently f that less artificial heat is necessary during the later stages of incubation 102–103° F. in the earlier stages is largely artificial heat, while the 103–104 the later stages would be the combined animal heat given off by the eg the artificial heat supplied by the heat radiator.

Under natural conditions eggs are cooled somewhat at inte during incubation when the hen leaves the nest.

It may be stated with a fair degree of certainty that the cooling of the is due to the necessity of obtaining food, and in no way fundamentally the growth of the chick when there is an abundant supply of fresh air. is not the least doubt, however, but what it has a beneficial influence of poor ventilation, and since no incubator is supplied with too much, ably is best to adopt the common practice of cooling the eggs. In so d would not seem advisable to cool the eggs for more than twenty t minutes each day for the first fifteen or eighteen days.

In natural incubation under usual conditions eggs are wel lated, as fresh air can always reach them by diffusing throug feathers which cover them and foul air pass off in the same way might be supposed, it has been found that the degree of ventila has a decided effect upon the percentage of eggs which hatch in bators. In the tests made at the University of St. Louis 85.7 pe of the fertile eggs hatched in an incubator provided with speci tilation, while only 44.3 per cent hatched in an incubator v ventilation.

When a perfect ventilation has been obtained it has produced certai terious effects which must be corrected. It is commonplace to say tha evaporation goes on in still air this air soon becomes saturated and e tion, if not stopped, goes on very slowly. If, however, the saturated air stantly removed and dry air takes its place, the rate of evaporation is in It is thus evident that any discussion of ventilation must take into consid the question of moisture.

CAUSES OF DEATH OF YOUNG CHICKS.[a]

It has been often noted that a large number of incubator chicks die during the first ten days in the brooder from a looseness of the bowels, which is commonly known among poultry men as white diarrhea. This trouble has been assigned to a variety of causes, among them being irregular temperature, lack of vitality of breeding stock, improper feeding, and poor ventilation not only of brooders but also of the rooms in which the incubators are kept. A committee of Ontario poultry experts after investigating the cause of this mortality among chicks in Ontario and New York concluded that the lack of ventilation was perhaps the most important of the determining factors.[b]

The Connecticut Storrs Experiment Station has recently studied this question, being led thereto by the fact that nearly every chick died of 400 hatched in February in different incubators, while large numbers of chicks hatched before and after this date did not exhibit any of the fatal symptoms. Believing that food was an important factor in the problem, C. K. Graham, who carried on the work, fed several lots of chicks with different kinds of feed and noted that the mortality was high in whichever lot received one of the grain mixtures. Careful examination showed that this feed contained a fairly large percentage of musty grain, particularly corn. The young chicks ate all the grains indiscriminately, and their lack of ability to detect wholesome from unwholesome foods was further tested by giving them rations which contained such substances as sawdust, coarse salt, and granulated sugar. These materials were eaten as readily as the grains with which they were mixed. Indeed, "the salt and sugar were always selected first, apparently owing to their bright appearance; but as a rule the chicks did not appear to relish them."

When older chicks hatched by hens, and also those taken from the incubators and given to the hens, were offered these same mixtures, it was exceptional to find a chick that took over a grain or two of salt, sugar, or sawdust.

When musty feed was given to the older incubator chicks it was noticed that those which were eight or nine days old showed considerable discrimination in selecting the grain, while still older chicks refused even larger proportions of the musty kernels.

This forces the conclusion that many of the deaths among young chicks are caused by musty food, although there is no doubt that faulty brooders, chills, overheating, improper ventilation, and lack of vitality in the parent stock should all receive proper credit for their share.

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[a] Compiled from Conn. Storrs Sta. Bul. 44.

[b] Ontario Agr. Col. and Expt. Farms Rpt. 1905, p. 230.

any or all of which may be set in operation in a given loca These methods are direct insecticide treatment of cattle with and other substances, rotation of pastures, and starvation of the by the removal of all animals from certain fenced areas.

When the suggestion of tick eradication was first made man those who were most familiar with the life history and habits of tick considered it as an impractical proposition. Certain o however, were more hopeful and began practical tests to deter the efficiency of the method. Without going into details of organization of these methods it may be stated that the results far obtained are so encouraging that even the most skeptical become convinced of the possibility of final tick eradication. L appropriations have been secured from Congress for the use o Bureau of Animal Industry in cooperation with State offic eradicating ticks in the various tick-infested States so that the antine line may be gradually pushed farther south. In a confe of Federal and State representatives engaged in this work, he Nashville, Tenn., on December 5, 1906, the work accomplished du the first five months was presented from a number of stand by a number of workers in different sections of the tick-inf States. As stated by Doctor Melvin, the reports received fro ous inspectors indicate that as a result of five months' work 50,000 square miles of infested territory had been freed fro and might therefore be placed north of the quarantine line work is being pushed vigorously in Virginia, North Carolina nessee, Arkansas, Oklahoma, and in other localities within th infested area, and in all localities the methods of starvation, p rotation, and direct treatment of cattle with insecticides have the desired results at a comparatively slight expense. In fac at present estimated that the total expense of the complete erad of the cattle tick from the United States will probably not exc amount of annual loss caused to the cattle industry by the pres the cattle ticks.

A great amount of this work on the part of Federal and inspectors and veterinary officials must be of an educational c It has been found necessary, in the first place, to convince the f of the practicability of freeing their farms from ticks and desirability of cooperating to the fullest extent in accompl these results. The educational propaganda of tick eradicati been carried on largely through farmers' institutes and les gatherings of farmers in tick-infested localities and through th sonal appeals of inspectors on their tour of inspection from fa farm. The results of this work are everywhere encouraging. seems reasonable to believe that in the future the quarantine lin be gradually pushed southward toward the Gulf.

3

ERADICATION OF CATTLE TICKS.[a]

The enormous handicap which the presence of Texas fever has placed upon the beef and dairy industries of the Southern States has long been familiar to all who have engaged in these lines of work, as well as to the reading public. The Bureau of Animal Industry made Texas fever one of its important lines of investigation, and solved the problem of the cause of the disease and the means by which it is transmitted. Following upon its preliminary work came the announcement of a satisfactory method for the immunization of northern cattle to Texas fever by the use of the blood of immune southern cattle. This method, first devised by the Bureau of Animal Industry, and later tested on a large scale and perfected in certain details by various experiment stations, has furnished safe means for the introduction of high-grade cattle into the South. This made possible the great improvement of existing beef and dairy cattle in that section of the country.

The ticks, however, still remain. They are recognized as the only means by which the disease may spread from one animal to another, and, in addition to transmitting the disease, they cause other almost equally serious financial losses. Badly infested cattle are kept in poor flesh, and in many instances fail to reach the size which they otherwise would, or fail to mature as early as they normally should. Some animals are killed outright by excessive infestation with ticks. The total annual loss attributable to cattle ticks in the Southern States has been estimated at $40,000,000. This loss is represented not only by the animals which die of Texas fever and of excessive tick infestation, but by the loss in weight and condition, and the depreciation in price of all tick-infested animals, due to the fact that they come from south of the quarantine line. One of the most serious economic results from the presence of cattle ticks in the Southern States is the annoyance, additional expense, and business complications due to the presence of the quarantine line running across the country from ocean o ocean.

For years the idea has been gaining ground that the only satisfactory way to solve the problem of Texas fever is to eradicate the icks and thus prevent the perpetuation of the disease. A large number of investigators have been engaged in a careful study of the life history of the cattle tick in order to determine whether its extermination is a feasible proposition and the methods by which this result may be most economically brought about. As a result of this investigation three general methods of tick eradication have been perfected, in cream ranged from a fraction of 1 per cent to 2 per cent in mer and from a smaller fraction to a little more than 1 per winter. As gas-producing bacteria are much more troubleso summer than in winter because a high temperature favor growth, there is need of greater care in performing dairy opera at that season of the year. Since large numbers of curd-dig bacteria are found in hay and straw, these feeding materials not be handled during the milking period.

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[a] Compiled from Georgia Sta. Buls. 49, 64; Louisiana Stas. Buls. 82, 84; South Carolina Sta. Bul. 130; Tennessee Sta. Bul., Vol. XVIII, No. 1; U. S. Dept. Agr., Bur. Anim. Indus. Buls. 1, 78, 97; Circ. 110; U. S. Dept. Agr., Farmers' Buls. 58, 261, and other sources.

The ordinary souring of milk is due to the action of lactic ba on milk sugar, changing it to lactic acid. Now, since rich contains a smaller amount of milk sugar than thin cream. it dent that the lactic bacteria will produce less acid in the rich in the thin cream.

Cream becomes more sour with age, though the number of bac is less after the third or fourth day, and it was found in these ex ments that the average cream more than two days old in summe too sour to be handled at a creamery with good results.

The results as a whole indicate as essentials of successful making in Oklahoma, as elsewhere, (1) clean milk, producing cream; (2) cleanly handling of the cream at low temperatur its prompt conversion into butter.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 310.

A SUCCESSFUL ALABAMA DIVERSIFICATION FARM.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., September 1, 19

SIR: I have the honor to transmit herewith a paper entitled Successful Alabama Diversification Farm," in which an accou given of the work done jointly by Mr. M. A. Crosby, Assistant A culturist, Farm Management Investigations, Bureau of Plant In try, Prof. J. F. Duggar, Director of the Agricultural Experim Station of the Alabama Polytechnic Institute, and Prof. W. J. S man, Agriculturist in Charge of Farm Management Investigati The paper gives an account of the first three years' work on the di sification farm on the plantation of Gen. T. T. Munford. I respectf recommend that it be issued as a Farmers' Bulletin.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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B. P. I.—314.

A SUCCESSFUL ALABAMA DIVERSIFICATION FARM.

INTRODUCTION.

In this bulletin is given the record of a 65-acre hog farm in the black prairie region of Alabama. The method of farming described is applicable to the entire area in which corn, alfalfa, and Bermuda grass can be grown. This area includes the black lands of Texas, the river bottoms of Missouri, Arkansas, Louisiana, and Mississippi, and the alluvial soils generally in all the Southern States. This method is especially adapted to the large area in Alabama and Mississippi known as the "black belt," in which the soil is peculiarly suited to alfalfa, and with only slight modification it is applicable to the whole area over which alfalfa or clover may be grown in this country. The primary object in the work of this farm was to demonstrate that hog farming is practicable in this territory, and three years' experience has led us to the conclusion that the production of alfalfa hay in this region can also be made highly profitable.

Alfalfa is not only adapted to the territory named, but succeeds on alluvial soils throughout the Southern States. The contents of this bulletin should therefore be of special interest to farmers in the river bottoms.

The system of farming established on the diversification farm at Uniontown, Ala., was planned with the special view of increasing the fertility of the soil and reducing the cost of tillage by doing away with hillside ditches and adopting improved methods of cultivation. Although on an average only 55 acres have been devoted to cultivated crops, the remainder being a worn-out hill, about 6 acres of which is in Bermuda grass, the farm has yielded in the three years a net profit of $2,320.39, or $773.46 a year. This is an average yearly profit of $11.90 an acre on land valued at $20 an acre.

The farm, designated as Diversification Farm No. 3, is located in what is known as the canebrake or black-prairie region of central Alabama. It is a portion of the 2,300-acre plantation of Gen. Thomas T. Munford. For several years this plantation has been under the management of Mr. William Munford, being devoted chiefly to the production of cotton. Mr. Munford has also had active charge of the diversification farm, and any success that has been met with is largely due to his good management and faithfulness in carrying out plans.

SOIL.

In contour the land of the black prairie belt varies from level to quite rolling. The soil is a brown, reddish brown, black, or gray limestone clay.[a] It is classified by the Bureau of Soils as Houston clay and Houston black clay, the former occurring on the rolling, hilly portions and the latter in the valleys and level areas. The Houston black clay is deeper and much more productive than the Houston clay.

When wet this soil becomes very plastic and sticky. When very dry it cracks, some of the fissures being 1 or 2 inches across and from 2 to 3 feet deep. If plowed when dry, the soil breaks up into huge clods. With the first rains, however, these clods disintegrate like slaking lime.

This is naturally a very productive soil, but a continual cropping for seventy-five or eighty years with cotton, and occasionally a little corn, has greatly exhausted the humus or vegetable matter on the more rolling land and correspondingly reduced its producing capacity. For this reason there is great need of a more diversified system of farming—one which will add humus to the soil and restore the land to its original state of fertility.

In selecting the site for this farm care was taken to choose an area which would fairly represent the average land of the surrounding country, so that any results obtained could not be credited to pecul soil or other abnormal conditions.

The soil on this diversification farm, with the exception of about 2 acres of Houston black clay in the northeast corner, practically all belongs to the Houston clay type. It is locally known as p hill land to distinguish it from the richer and more productive bott lands. Four years ago one-third of a bale of cotton and from 15 to bushels of corn to the acre would have been considered an average yield.

TYPE OF FARMING.

The farm described in this bulletin was established to determine whether pork could be produced on the plantation at a profit to owner. Throughout the cotton-growing sections of the Southern Sta pork is the chief article of food consumed by the colored laborer, but as the bulk of it comes from the great corn belt of the North and West the amount required on a large plantation represents a considerable outlay of cash each year. The production of this meat on the plantation where it is consumed means not only a saving in actual cash outlay, but also necessitates the growing and feeding of a large quantity of forage, the surest and quickest way of increasing the fertility of the land.

---

[a] It is said that this soil owes its origin to a cretaceous sediment laid down rapidly deepening sea. It is known as the rotten limestone or Selma chalk forma practically the whole area being underlaid at varying depths with a rotten limest Ledges of a more resistant lime rock outcrop on many of the ridges. The soil is shells and sharks' teeth and of vertebræ and other fossil remains of marine life

Owing to the deficiency of humus in the soil, it was necessary to adopt a cropping system which would supply this essential constituent and at the same time furnish the feed required by the hogs. A rotation was planned with the view of building up the soil rather than of securing the maximum yields of any crops other than those necessary for the maintenance and fattening of the hogs.

ROTATION.

A four-year rotation with alfalfa two years and corn and cowpeas two years in succession was decided upon. The alfalfa is sown early in the spring, cut for hay the first year, pastured by the hogs the second year, and then broken up for corn, the corn to be followed each time with cowpeas, the latter being sown broadcast ahead of the cultivators at the last working of the corn and grazed off by hogs after the corn has been harvested. In addition a few acres were set aside for such crops as sorghum and peanuts for soiling and pasture. This rotation provides for the turning under of a leguminous crop each time the land is broken; first the alfalfa, then the cowpeas, which follow the corn. Ten acres of cotton were grown the first year for a money crop to offset any loss that might occur from the change of system.

Alfalfa is not generally considered a suitable crop to utilize in a short rotation, and ordinarily it would not be recommended for such use, particularly when a maximum yield of hay is one of the objects sought. But in this case, where the yield of hay was a secondary consideration as compared to the production of hog feed and the building up of the soil, alfalfa suited the purpose admirably. The results obtained the past year (1906) from plowing up a 2-year-old stand of alfalfa for corn indicate quite clearly that, in this section at least, alfalfa can be utilized to good advantage in a comparatively short rotation.

It is planned to continue this rotation only until each field has had one crop of alfalfa plowed under. By that time the soil should be sufficiently rich in humus to permit the paying of more attention to alfalfa hay production. A rotation will then be planned which will allow the alfalfa to remain for several years, and the production of hay will become one of the prime factors.

ARRANGEMENT OF FIELDS.

At the beginning of the work in 1904 the land was divided by t driveway and old hillside ditches into irregular fields of various siz As the work was not started until late in the season, it was impo sible to change the arrangement of the fields. This would hav delayed the planting, and thus materially interfered with the yea work. Consequently, part of the area now included in the farm w not used at all the first year and part of that used extended beyo the limits of the farm as it stands to-day. In fact, it was not un the third year that it was possible to get the farm laid out in fields of nearly equal size as originally planned and start the regul rotation.

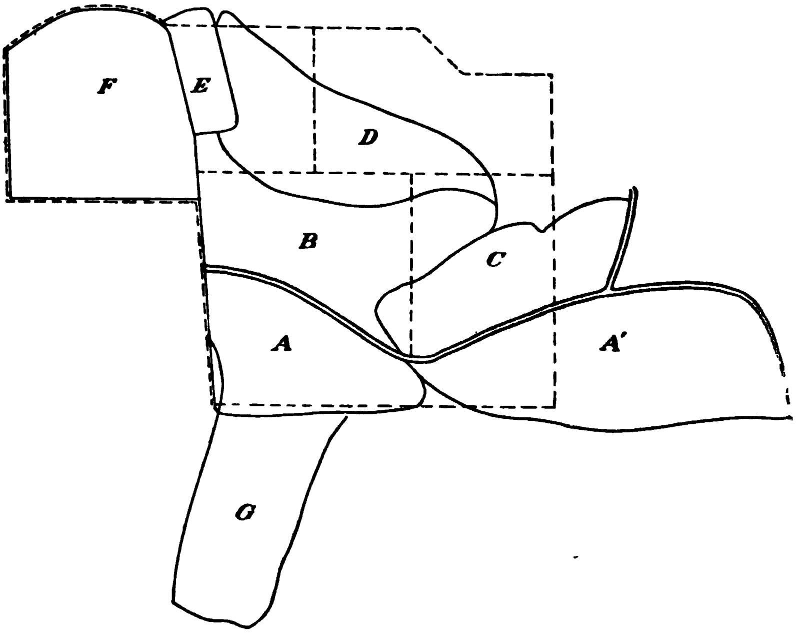

FIG. 1. Diagram of farm, showing arrangement of fields in 1904.

Figure 1 shows the general layout of the farm for the first y The solid lines show the boundaries of the fields that were cro in 1904. The broken lines show the rearrangement of the fields the boundaries of the total area included in the farm since the year.

Fields *A*, *B*, *C*, and *D* are to be devoted to the rotation previ mentioned. On field *E* will be grown sorghum and other cro be used for soiling or pasture, while field *F* is a permanent Ber pasture, where the hogs can be grazed during wet weather, when trampling might injure the alfalfa fields. Field *G* was only inc in the farm the first year. None of the fields is permanently fenced except field *A*. When a field is to be pastured, it is inclosed by a temporary 26-inch woven wire fence.

Figure 2 shows the arrangement of the hillside ditches at the beginning of this work and during the summer of 1904. These ditches (*a*, *a*, *a*) had been constructed several years before to keep the soil from washing during the heavy rains. They cut the fields up into irregular patches and occupied considerable valuable land that should have been in crops. They were also infested with Johnson grass, and consequently were a source of constant annoyance. In the fall of 1904 it was decided to do away with these hillside ditches and depend upon deep plowing and getting enough humus in the soil to prevent washing. The results of this experiment have so far been highly satisfactory. During the summer of 1905 no washing occurred, although some very heavy rainfalls were recorded. During the torrential rains which occurred in 1906 there were some slight washings, but not enough to do any material damage, while many other lands in the vicinity, even when protected by the hillside ditches, were badly gullied.

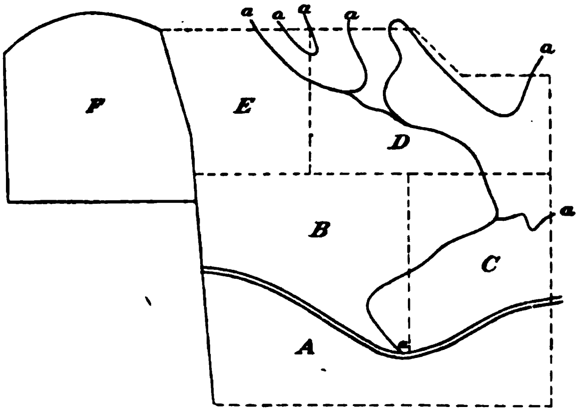

Fig. 2. Diagram of farm, showing the location of hillside ditches in 1904.

MANAGEMENT OF HOGS.

At the beginning of the work Mr. Munford had on hand 66 head of hogs, ranging in age from 2 weeks to 2 years. These were for the most part grade Berkshires, but a registered Berkshire boar headed the herd. Since that time several pure-bred sows have been added to the herd and the grades gradually killed off, so that now all the animals on hand are pure bred, and the majority are eligible to registry.

The original plan of management was to keep from 12 to 16 brood sows, have the pigs dropped in the early spring, push them through the summer months, and dispose of them when they were 8 or 9 months old. This would undoubtedly have been the most economical practice, as the high price of grain which prevails throughout the Southern States makes it very expensive to carry through the winter any animals except those wanted for breeding purposes. Unfor nately, however, several of the young sows were permitted to with pig late in the season, so that each winter there has been q a number of fall pigs to carry over. This added expense has ma rially lessened the profits.

PASTURE.

The hogs are pastured to some extent every month in the alfalfa furnishing most of the pasture. This pasturage is supp mented during part of the summer months with daily feeds of gr sorghum, and later, after the corn has been harvested, the hogs h the run of the corn and pea fields and derive considerable nutriti feed from that source. During wet weather, when their trampli might injure the alfalfa plants, they are run on a Bermuda pas containing some white clover. This Bermuda grass, not be closely grazed during the summer, makes a matted growth wh does not all kill down with the early freezes, and therefore furni some roughage for the animals during the winter months, thoug no means as much as they need.

WATER SUPPLY.

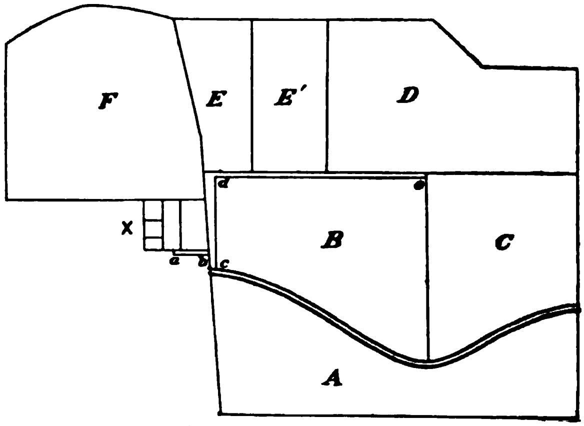

FIG. 3. Diagram of farm, showing arrangement of fields in 1906.

The water supply comes from a deep well. The water is raise means of a hot-air pump and is piped to the troughs in the fee lots. An automatic device regulates the flow so that the troughs kept full all the Figure 3 shows arrangement of temporary la which lead from feeding lots to different fields, permitting the h to have ready ac to the water a times. Lane leads from the ing lots to the *c–d*. Field *A* reached by a way under a drive at *c*; *B*, by a similar runway under the *c–d*, and fields *C*, *D*, and *E* by the lanes *c–d* and *d–e*. This proved a very satisfactory arrangement. During the long summer days the animals consume an enormous quantit water, and to attempt to carry this to them, instead of letting come to the water, would be a very expensive process. Then. a when the days are long and hot the hogs graze only during the cool hours of the morning and evening, spending the heated portion of the day in the shade furnished by the trees and sheds in the feeding lots.

GRAIN FED AND METHODS OF FATTENING.

Grain is fed during the entire year, not in sufficient quantity to keep the animals fat, but just enough to keep them in a good, thrifty, growing condition. During the winter months they are fed on corn, with occasionally some oats, mill stuff, rice polish, etc. While on alfalfa pasture they receive very little grain, generally not over 1 pound of grain to each hundred pounds the animal weighs. As the time for fattening approaches, the hogs that are to be killed have their allowance increased until they are on nearly a full grain ration. They are then taken from the pasture and kept in the feeding pens and fed all the corn they will consume without waste.

When ready to kill, the hogs are sold alive to the plantation. As the quantity of meat produced has never exceeded that required for the rations supplied to the plantation labor, all the finished animals have each year been turned over to the plantation and the farm credited with the amount they would have brought in the open market.

In discussing the methods of growing and handling the crops each year's work has been dealt with separately. This was thought best to bring out to better advantage the difficulties attending the work at the beginning, the development of better practices of tillage, and the comparative cost of producing crops under the old and newer methods. The tables following the discussion of each year's crops represent actual costs based on daily records kept by Mr. Munford.

In computing the cost of production of the different crops the customary wages paid to day labor has been used as the basis. This is 50 cents a day for a man and the same amount for a mule. A man, two-horse team, and plow or harrow cost $1.50 a day. This may appear a very low rate to some, but this is the usual rate in this section for this grade of labor. While most of the work was performed by day labor, part was done by farm hands who were getting $10 a month. The computations, however, were all based on the rate paid to day laborers and no reduction was made for the cheaper month hands. Since all the work was done by labor and tools hired from the plantation, no allowance has been made for depreciation in value of the tools.

In determining the cost of keeping the hogs, all crops fed (pasture excepted) have been charged against their feed bill at the regular market prices. In the case of the sorghum, where there was no market price by which to be guided, a charge of $2 per ton for the green forage was made. The cost of producing the cowpeas and pea nuts which were grazed off by the hogs was not charged against the but to the field crop account, as it was estimated that the manur value of these crops would offset what it cost to produce them.

OPERATIONS FOR 1904.

The acreage of crops grown during 1904 is as follows: Alfalfa acres; corn and cowpeas, 24 acres; cotton, 10 acres; sorghum acres; and melilotus, 10 acres. All the land had been in cotton previous year and, with the exception of that planted to cotton sorghum and a small area of the corn land which was too wet to early, had been plowed during the early winter. This, together the fact that the work was not started until planting time, preven the giving of any special attention to the breaking of the land.

ALFALFA.

The alfalfa was sown in two fields (*A* and *B*, fig. 1), of 7 and acres, respectively. In preparing for planting, the land previ plowed was disked each way and then harrowed with a smooth harrow. The seed was sown broadcast at the rate of 25 poun the acre and lightly covered with a smoothing harrow. Previo sowing the seed an application of 200 pounds of cotton-seed and 160 pounds of acid phosphate to the acre was made. Field *A* sown March 19 and field *B* March 24. In both fields an al perfect stand was secured.

The alfalfa grew rapidly and was cut on June 13, field *A* yield total of 7,000 pounds of cured hay, or 1,000 pounds to the acre field was then fenced off and from July 14 to September 1 furn pasturage for 57 head of hogs. This number of animals was not cient to keep down the growth, however, so it was necessary the alfalfa again on August 17, when a yield of 1,061 pounds to the acre was secured. Field *B* was cut three times during season. The first cutting, June 13, gave a yield of 700 pounds to the acre; the second, August 4, 2,374 pounds; and the third tember 19, 1,112 pounds, a total yield of 4,186 pounds of hay to acre, all secured within five months after sowing the seed.

CORN.

The corn land (fields *A'* and *C*, fig. 1), with the exception of a low, wet area in *A'* (*a*, fig. 4), had been bedded into rows apart in the manner customary to the region. These beds were over with a smoothing harrow and the corn planted April 6 one-horse planter. The low, wet area in *A'* was broken with horse turn plow early in April, disked once each way, thoroughly rowed with a smoothing harrow, and planted April 24. The variety planted in both cases was Cocke's Prolific. The first week in May cotton-seed meal at the rate of 200 pounds to the acre was applied at the side of each row with a one-horse fertilizer distributer. Four shallow cultivations with sweeps were given—one in April, two in May, and one in June. At the last cultivation cowpeas were sown ahead of the cultivators at the rate of 1½ bushels to the acre.

The corn was cut by hand August 16 to 26 and set up in shocks containing about seventy hills each. In October the ears were snapped from the stalks, and both grain and stover were hauled to the barn and stored. The total yield for the 24 acres was 490 bushels, or a fraction over 20 bushels to the acre.

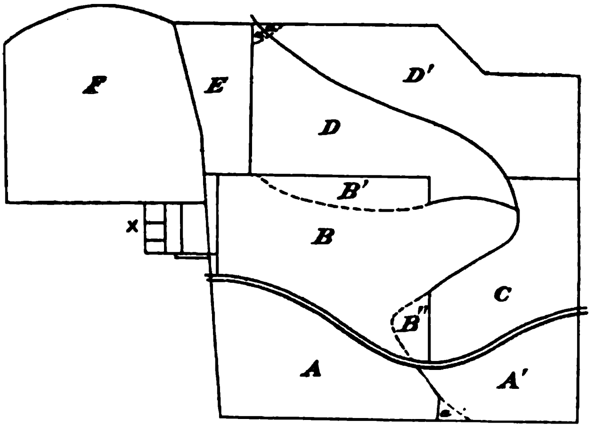

FIG. 4.—Diagram of farm, showing arrangement of fields in 1905.

Forty bushels of the peas were picked and saved for the next year's seed, and the rest were grazed off by the hogs.

COTTON.

The cotton land (field *G*, fig. 1) was plowed into 4-foot beds the latter part of February, harrowed with a smoothing harrow, and planted March 30 to April 4. The soil on this field averaged a little better than the rest of the farm, as it contained more bottom land. The variety planted was Culpeper, and only a fair stand was secured. Five cultivations and three hoeings were given during the season. One cultivation was with a weeder, the rest with 12 and 24 inch sweeps. An application of 200 pounds of cotton-seed meal and 100 pounds of acid phosphate to the acre was made at the side of each row the latter part of May. The picking began September 22 and lasted until November 30. The total yield of lint was 2,650 pounds, or 265 pounds to the acre, and the total yield of seed was 8,350 pounds, or 835 pounds to the acre. Considering the stand secured this was a very good yield.

MELILOTUS.

The melilotus was sown primarily as a soil renovator. The land (field *D*, fig. 1), which had been plowed in December of the previous year, was run over once with a disk harrow and then with a smoothing harrow. Seed of *Melilotus alba* in the hull was sown March 27 at the rate of 2 bushels to the acre and covered lightly with a smoothing harrow. An excellent stand was secured. The crop was mowed twice during the season. The first cutting, April 22, made a yield of 1 ton of cured hay to the acre, and the second cutting, August 19, made a yield of almost 1¼ tons to the acre. This hay was of fine quality and was relished by horses and mules.

SORGHUM.

Field *E*, figure 1, which was devoted to sorghum, was plowed April 20, disked once each way, thoroughly harrowed with a smoothing harrow, and planted April 24, 1 peck of seed to the acre being sown in drills 2 feet apart. The variety was Early Amber cane. Two cultivations were given with 15-inch sweeps. The sorghum was utilized as a soiling crop for hogs from September 1 to October 15. The total yield of green forage was estimated at 16 tons.

RECEIPTS AND EXPENDITURES FOR 1904.

The following tables (Tables 1, 2, 3, and 4) show the cost of production, receipts, and net profit for each crop grown in 1904. Each field is considered separately.

TABLE 1.—*Cost per acre of producing and harvesting crops, 1904.*

Field.	Area, in acres.	Crop.	Cost of preparing land.	Cost of seed, planting, and replanting.	Cost of fertilizer and applying same.	Cost of cultivation and hoeing.	Cost of harvesting.	Total cost per acre.
A	7	Alfalfa (pasture)	$1.39	$4.11	$2.47		$1.03	$9.00
B	10	Alfalfa (meadow)	1.05	3.30	2.04		1.24	7.63
A′ and C	24	Corn	1.17	.76	2.15	$2.08	1.16	7.32
A′ and C	24	Cowpeas		2.05			.37	2.42
D	10	Melilotus	1.30	1.20			1.30	3.80
E	2	Sorghum	2.50	.92		3.25	4.00	10.67
G	10	Cotton	1.20	1.96	3.36	[a] 4.35	3.00	13.87

[a] Includes ginning, baling, and marketing.

TABLE 2.—*Crop yield, cost, and returns per acre, 1904.*

Field.	Area, in acres.	Crop.	Yield.	Price.	Gross returns.	Cost.	Net returns.
A	7	Alfalfa (pasture)	1.03 tons	$12.00 ton	$12.36	$9.00	[a] $3.36
B	10	Alfalfa (meadow)	2.08 tons	12.00 ton	24.96	7.63	17.33
A′ and C	24	Corn	20.4 bu. grain 0.58 ton stover	.50 bu 2.00 ton	10.20 1.16	7.32	4.04
A′ and C	24	Cowpeas	[b] 40 bu			2.42	
D	10	Melilotus	2.23 tons	8.00 ton	17.84	3.80	14.04
E	2	Sorghum	8 tons	2.00 ton	16.00	10.67	5.33
G	10	Cotton	265 lbs. lint 835 lbs. seed	.07$\frac{9}{16}$ lb 15.00 ton	20.04 6.27	13.87	12.44

[a] In addition to pasture.

[b] Not sold; kept for seed.

Table 3.—*Hog record for 1904.*

	Dr.	Cr.
Hogs on hand January 1, 1904:		
66 sows, pigs, and shoats, average weight 75 pounds, at 5 cents	$247.50	
1 boar	25.00	
2 gilts, bought in August, at $20	40.00	
1 sow, bought in September	40.00	
2 gilts, bought in October, at $20	40.00	
72	392.50	
Cost of feed for the year	539.60	
Receipts for hogs sold		$559.86
96 hogs kept over for 1905		502.50
Total	932.10	1,062.36
Net profit		130.26

Table 4.—*Summary of receipts and expenditures for 1904.*

Field.	Crop.	Area, in acres.	Dr.	Cr.	Net profits.
A	Alfalfa (pasture)	7	$63.00	[a] $86.52	
B	Alfalfa (meadow)	10	76.30	249.60	
A' and C	Corn	24	175.68	272.64	
	Cowpeas		58.08		
D	Melilotus	10	38.00	178.40	
E	Sorghum	2	21.34	32.00	
G	Cotton	10	138.70	263.10	
			571.10	1,082.26	
Net profit from crops on 63 acres					$511.16
Hog record.					
Hogs on hand January 1, and expenses			932.10		
Hogs on hand December 31, and sales				1,062.36	
Net profit from hogs					130.26
Total net profit for year					641.42
Net profit per acre (including Bermuda pasture)					8.44

[a] In addition to pasture.

OPERATIONS FOR 1905.

At the beginning of the year 1905 several changes were made in the arrangement of the fields. (See fig. 4.) While it was still impossible to put into full operation the rotation decided upon, the arrangement of the fields was more in conformity with the original plans. The operations this year were confined to the 52 acres (exclusive of the Bermuda pasture), but as there were some thin, galled portions of this in melilotus (fig. 4, *a*, *a*,), which was used only as a soil renovator, the total area devoted to crops was only 50½ acres, of which 7 acres were in alfalfa pasture, 10 acres in alfalfa meadow, 22 acres in corn and peas, 3½ acres in sorghum, and 8 acres in cowpeas.

ALFALFA.

The alfalfa in the 7-acre field, *A*, was again utilized for pastur On March 28, 115 head of hogs were turned on this field, and August 2, 8 more animals were added. The pasturing was continued until about the 1st of October.

In the meantime it was found necessary to mow a portion of th alfalfa at two different times, for, as in the previous year, the numbe of animals was not sufficient to keep the crop grazed down. Th entrance to the pasture being at the northwest corner of the field th hogs kept that portion grazed much closer than the rest, and it onl required one mowing. The east half of the field was mowed May 1 and yielded at the rate of 2,066 pounds of hay to the acre for th area that was cut over. The second cutting was made on June and a yield of 1,035 pounds to the acre was secured. The west ha of the field was cut June 12, the yield being only about 143 pounds t the acre.

In straightening out the lines between the different fields, portio of what were included in *C* and *D* in 1904 were added to *B*. The areas were plowed up and seeded to alfalfa in March, 1905. On th area *B''*, fig. 4, a fine stand was secured, but for some reason it ma but little growth during the season. This may have resulted fr the fact that the land was broken deeply with a disk plow and h not settled and become firm before the alfalfa was sown. The a *B'* was too wet for alfalfa, and as the land was badly infested w Johnson grass the young seeding was practically all killed out.

Five cuttings in field *B* were secured during the season from seeding of the previous year, the first and second being much heav than the other three. The total yield of hay for the year was tons to the acre.

WINTER BARLEY.

After the corn stover had been removed from fields *A'* and *C* 1904 the land was broken to an average depth of 8 inches wit disk plow and was sown to winter barley in November. The p was to utilize this crop as a winter pasture for the hogs. Owing the lateness of sowing and the very dry weather which prev during November and December, the crop never made a satisfac growth and was of little or no use as a pasture. Could it have b sown a month or so earlier there is no doubt that a large amoun grazing would have been secured, as it made a very rapid grow the spring after the weather moderated. In March this barley plowed under with a two-horse turn plow and the land prepared corn.

CORN.

The method followed in preparing the land for corn differed materially from that of the previous year. This year the land in field *D* was thoroughly broken with a disk plow to an average depth of 8 inches, that in fields *A′* and *C* having been thus broken in preparation for the barley. The hillside ditches (fig. 2) were all plowed and harrowed down until little evidence of them remained. After breaking, the land was thoroughly harrowed with a smoothing harrow. Instead of running the rows with the contour of the land, as is the usual practice in this section, the fields were marked off in rows 3 feet apart each way and the corn planted in the check. The dates of planting ranged from April 3 to 11, the variety planted being Tennessee Red Cob. Cutworms greatly damaged the stand in field *A′*, making several replantings necessary, and completely ruined that in field *C*, so that the latter field had to be disked, harrowed, and replanted on May 30 and 31. These pests gave no trouble except on the land where the barley was plowed under. Owing to the lateness of this second planting in field *C* a large early-maturing variety of corn known as Mexican June was used.

Four cultivations were given. The first was with a weeder, the second and third with 12-inch sweeps, and the last with double sweeps. The latter implement consists of a double stock to which are attached two sweeps, one 10 and the other 14 inches in width. This is a great improvement over the old-fashioned wide sweep in that it is easier to handle and leaves the ground nearly level.

On the poorer portions of fields *A′* and *D′* nitrate of soda at the rate of 80 pounds to the acre was applied at the side of the row about the middle of May. The first week in June cotton-seed meal at the rate of 100 pounds to the acre was applied in a similar manner to the entire crop on these fields. Field *C* received an application of 200 pounds of cotton-seed meal to the acre the first week in July.

The corn was harvested in the same manner as was the 1904 crop. The yields of corn (all preceded by cowpeas or melilotus) for the different fields were as follows: *A′*, 112 bushels, or 24.89 bushels to the acre; *C*, 137 bushels, or 19.42 bushels to the acre; and *D′*, 331 bushels, or 31.52 bushels to the acre. The uneven stand in field *A′*, resulting from the frequent replantings, and the fact that the Mexican June variety proved to be a comparatively light producer account for the relatively low yield from fields *A′* and *C*.

COWPEAS.

The latter part of June field *D* was thoroughly pulverized with a disk harrow, and it was sown to cowpeas on July 5, 1¾ bushels of seed being used to the acre. Four acres of these cowpeas were cut for hay August 23, and a yield of 4.49 tons was secured. The remainder of the peas was grazed off by hogs and plowed under fertilizer.

SORGHUM.

Field *E* was somewhat enlarged in 1905 and again sown to Ear Amber sorghum. The method of preparing the land for plantin the cultivation, and the harvesting were the same as practiced 1904. The yield was rather light, being only 13.12 tons of gr forage for the entire field, or 3.76 tons to the acre. This light yi was undoubtedly the result of planting sorghum after sorghum practice which will be guarded against in the future.

RECEIPTS AND EXPENDITURES FOR 1905.

Tables 5, 6, 7, and 8 show the cost of production, receipts, a net profit for each crop grown in 1905, each field being consider separately.

TABLE 5.—*Cost per acre of producing and harvesting crops, 1905.*

Field.	Area, in acres.	Crop.	Cost of preparing land.	Cost of seed, planting, and replanting.	Cost of fertilizer and applying same.	Cost of cultivation and hoeing.	Cost of harvesting.
A	7	Alfalfa (pasture)		[a] $0.62			$0.41
B	10	Alfalfa (meadow)		[a] .59			3.90
A′ and C	11½	Winter barley	$1.48	1.29			
A′	4½	Corn	3.52	1.75	$3.73	$1.50	2.71
A′	4½	Cowpeas		[b] .11			
C	7	June corn	1.78	.82	2.41	1.45	2.04
C	7	Cowpeas		1.25			
D′	10½	Corn	2.21	.70	3.85	1.33	3.06
D′	10½	Cowpeas		.11			
D	8	do	1.12	.24			[illegible]
E	3½	Sorghum	2.21	1.26		1.12	3.39

[a] Cost of resowing thin spots.

[b] Cost of labor in sowing seed.

TABLE 6.—*Crop yield, cost, and returns per acre, 1905.*

Field.	Area, in acres.	Crop.	Yield.	Price.	Gross returns.	Cost
A	7	Alfalfa (pasture)	0.813 ton	$12.00 ton	$9.75	$1.03
B	10	Alfalfa (meadow)	4.697 tons	12.00 ton	56.36	4.49
A′ and C	11½	Winter barley				2.77
A′	4½	Corn	24.89 bu. grain 1 ton stover	.50 bu 2.00 ton	12.45 2.00	13.21
A′	4½	Cowpeas				.11
C	7	June corn	19.58 bu	.50 bu	9.79	8.4[illegible]
C	7	Cowpeas				1.25
D′	10½	Corn	31.52 bu. grain 1 ton stover	.50 bu 2.00 ton	15.76 2.00	11.17
D′	10½	Cowpeas				.11
D	8	do.[b]	.56 ton	12.00 ton	6.72	1.36
E	3½	Sorghum	3.74 tons	2.00 ton	7.48	7.98

[a] In addition to pasture.

[b] Only 4 acres cut for hay, the remainder being pastured and plowed under.

[c] Loss.

TABLE 7.—*Hog record for 1905.*

	Dr.	Cr.
gs on hand January 1, 1905:		
1 boar	$25.00	
9 sows, at $25	225.00	
5 gilts, at $10	50.00	
81 shoats and pigs, average weight 50 pounds, at 5 cents	202.50	
1 sow bought in February	133.00	
1 sow bought in November	40.00	
1 sow bought in November	20.00	
99	695.50	
t of feed for the year	551.44	
eipts for hogs sold		$772.78
hogs kept over for 1906		690.50
Total	1,246.94	1,463.28
Net profit		216.34

TABLE 8.—*Summary of receipts and expenditures for 1905.*

Field.	Crops.	Area in acres.	Dr.	Cr.	Net profits.
	Alfalfa (pasture)	7	$7.21	[a] $68.32	
	Alfalfa (meadow)	10	44.90	561.60	
nd C	Winter barley [b]	11½	31.86		
	Corn	4½	59.44	65.02	
	Cowpeas (pastured)		.50		
	June corn	7	59.29	68.32	
	Cowpeas (pastured)		8.75		
	Corn	10½	117.28	186.48	
	Cowpeas (pastured)		1.15		
	Cowpeas (hay and pasture)	8	14.72	53.76	
	Sorghum	3½	27.93	26.18	
			373.03	1,029.68	
Net profit from crops on 50½ acres					$656.65
Hog record.					
s on hand January 1, and expenses			1,246.94		
s on hand December 31, and sales				1,463.28	
Net profit from hogs					216.34
Total net profit for year					872.99
Net profit per acre (including Bermuda pasture)					13.75

[a] In addition to pasture.

[b] Winter barley was followed by corn same year.

OPERATIONS FOR 1906.

n 1906 it was possible for the first time to divide the farm into manent fields and get the regular rotation of alfalfa, corn, and peas ted. Fields *A*, *B*, *C*, and *D*, figure 3, will now be devoted to this ation until each field has been in alfalfa for two years. The crop- system will then be changed in order to leave the alfalfa for a er period before breaking it up. The acreage of the crops this r was alfalfa pasture, 10 acres; alfalfa meadow, 10 acres; corn peas, 24½ acres; sorghum, 4½ acres; and peanuts, 3 acres.

CORN.

Figure 3 shows the arrangement of the fields for 1906. Field and *D* were planted in corn. Part of field *A* was in corn and pe in 1905, while the rest had been in alfalfa pasture two years. Th portion of field *A* which had been in alfalfa pasture for two yea was broken with a disk plow to an average depth of 8 inche November, 1905. The continued pasturing had packed the gro so that it was very hard in places and exceedingly difficult to bre consequently, portions of the field were not plowed satisfacto Early in April the land was rebroken to a depth of 5 inches w two-horse turn plows and harrowed twice with a smoothing harr The remainder of field *A* and all of field *D* were broken wi disk plow.

The corn was planted April 12 to 18 with a check-row plan The rows were 4 feet apart each way, and from 3 to 4 grains w dropped to the hill. Tennessee Red Cob was the variety plan The corn was thinned to two stalks in the hill. The stand in f *A* was quite badly injured by cutworms, which made several rep ings necessary. This, together with the extra breaking, gre increased the cost of production.

The east end of field *A*, which was in corn in 1905, was giv dressing of about 4,225 pounds of stable manure to the acre pre to the breaking of the land. Early in June the whole of fiel received an application of 75 pounds of nitrate of soda to the Later, 125 pounds to the acre of a mixture of 400 pounds of acid p phate, 25 pounds of kainit, and 100 pounds of cotton-seed mea applied. Field *D* received a similar quantity of this mixture an pounds of nitrate of soda to the acre.

In harvesting, the yields on the two different portions of fie were kept separate in order to note the fertilizing effect of the al on the crop. The east portion of the field, which had been in and peas the year previous and had received a good applicati stable manure this year, made a yield of $32\frac{9}{10}$ bushels to the The rest of the field, which had been in alfalfa for two years, a yield of 45 bushels to the acre—a fraction over 12 bushels per in favor of the alfalfa land. Field *D* yielded at the rate of bushels to the acre.

ALFALFA.

Field *B*, which had been in alfalfa meadow for two years utilized for hog pasture in 1906. Ninety-three head of hogs pastured on the field from March 30 until November 4. The end of the field was cut for hay twice during the season and th end three times. The yield from these cuttings was 24.285 p or 1¼ tons per acre.

Field *C* was sown to alfalfa this year. The land was broken deeply with a disk plow in November, turning under the corn stubble and cowpeas that had been grazed off, and then put in fine condition with a smoothing harrow early in February. Previous to the breaking of the land, stable manure at the rate of 7 tons to the acre was applied on the poorer parts of the field. The seed was sown broadcast at the rate of 20 pounds to the acre the 1st of March and lightly covered with a smoothing harrow. A perfect stand was secured. Three cuttings were made during the season. The total yield of cured hay secured was 43,750 pounds, or 2¼ tons to the acre.

SORGHUM.

Field *E'*, figure 3, formerly a part of field *D*, which was in melilotus and cowpeas in 1905, was this year planted to sorghum. The land was prepared as for corn the latter part of January. The seed was drilled in rows 3 feet apart May 9, 1 peck of Amber cane seed to the acre being used. Thorough cultivation with double sweeps was given. The feeding of the green sorghum to the hogs began July 7 and continued until September 19. The total yield of green forage was a little less than 34 tons, or more than 7½ tons to the acre.

PEANUTS.

Peanuts were planted on field *E*. The land was broken with a disk plow the latter part of March and thoroughly harrowed with both disk and smoothing harrows. Planting was done May 10 to 14, 1¼ bushels of nuts in hulls being used to the acre. The rows were 3 feet apart. The stand secured was poor, and the crop does not seem to do well on the type of soil in this field (Houston black clay). As the hogs were allowed to do the harvesting, none of the nuts were saved; consequently, no record of the yield was obtained.

RECEIPTS AND EXPENDITURES FOR 1906.

Tables 9, 10, 11, and 12 show the cost of production, receipts, and net profit for each crop grown in 1906, each field being considered separately.

TABLE 9.—*Cost per acre of producing and harvesting crops, 1906.*

Field.	Area, in acres.	Crop.	Cost of preparing land.	Cost of seed, planting, and replanting.	Cost of fertilizers and applying same.	Cost of cultivation and hoeing.	Cost of harvesting.	Total cost.
A	12	Corn	$4.63	$1.34	$3.48	$1.16	$0.97	$11.58
A	12	Cowpeas		2.91				2.91
B	10	Alfalfa (pasture)					1.29	1.29
C	10	Alfalfa	2.40	4.68	2.57		1.58	11.23
D	12½	Corn	1.79	.51	2.54	2.03	.63	7.50
D	12½	Cowpeas		2.68				2.68
E	4½	Sorghum	3.53	.52		.92	2.80	7.77
E'	3	Peanuts	1.25	3.00		5.06		9.31

TABLE 10.—*Crop yield, cost, and returns per acre, 1906.*

Field.	Area, in acres.	Crop.	Yield.	Price.	Gross returns.	Cost.
A	12	Corn	39.67 bu	$0.50 bu	$19.83	$11.58
A	12	Cowpeas				2.91
B	10	Alfalfa (pasture)	1.214 tons	12.00 ton	14.57	1.29
C	10	Alfalfa (meadow)	2.187 tons	12.00 ton	26.24	11.23
D	12½	Corn	33.72 bu	.50 bu	16.86	7.51
D	12½	Cowpeas				2.68
E	4½	Sorghum	7.55 tons	2.00 ton	15.10	7.77
E′	3	Peanuts				9.31

[a] In addition to pasture. [b] Seeded in March, 1906.

TABLE 11.—*Hog record for 1906.*

	Dr.
Hogs on hand January 1, 1906:	
1 boar	$25.00
1 sow (pure-bred Berkshire)	133.00
9 sows, at $25	225.00
5 sows, at $15	75.00
93 shoats and pigs, average weight 50 pounds, at 5 cents	232.50
109	690.50
Cost of feed for the year (estimated)	954.85
96 hogs kept over for 1907	
Receipts for hogs sold	
Total	1,645.35
Net profit	

TABLE 12.—*Summary of receipts and expenditures for 1906.*

Field.	Crop.	Area, in acres.	Dr.	Cr.
A	Corn	12	$138.96	$237.96
	Cowpeas (pastured)		34.92	
B	Alfalfa (pasture)	10	12.90	[a] 145.70
C	Alfalfa (meadow)	10	112.30	[b] 262.40
D	Corn	12½	93.87	210.75
	Cowpeas (pastured)		33.50	
E	Sorghum	4½	34.96	67.95
E′	Peanuts	3	27.93	
			489.34	924.76
Net profit from crops on 52 acres				
Hog record.				
Hogs on hand January 1, and expenses			1,645.35	
Hogs on hand December 31, and sales				2,016.75
Net profit from hogs				
Total net profits for year				
Net profit per acre (including Bermuda pasture)				

[a] In addition to value of pasture. [b] Seeded in March, 1906.

FUTURE PLANS.

As previously mentioned, the present rotation will be run only until a crop of alfalfa has been plowed under on each field. After that a cropping system will be planned which will allow the alfalfa to remain three or four years before it is broken up. This will probably necessitate bringing field *E* into the regular rotation and taking in an additional field for growing sorghum, etc. A five-year rotation of alfalfa, corn, and cowpeas can then be adopted. The alfalfa can be left on the field three years, two years for meadow and one year for pasture. It will then be broken up and put in corn and cowpeas for two years.

One of the greatest drawbacks to the present system is the lack of an abundance of pasturage from the middle of December to the middle of March. Plenty of grazing at this time of the year would greatly lessen the quantity of grain required for wintering the animals that are kept over, and this would correspondingly reduce the cost of pork production. To meet this demand for winter grazing an additional area of 10 acres was added to the farm in the fall of 1906. This was very poor worn-out land which had not been cropped for several years. It will be used almost exclusively for growing annual pasture crops. Rye was sown on this field in September. This will be used for pasture until spring, then plowed under, and the land planted to cowpeas and peanuts. Part of the cowpeas will be harvested for seed, and the remainder, together with the peanuts, will be grazed off by the hogs. Vetch was sown with the rye on 1 acre of this land. If this crop succeeds it will be sown with the rye in the entire field in the autumn. This plan of cropping will be continued until the land becomes sufficiently fertile to grow a greater variety of crops.

CONCLUSION.

The results of the three years' work indicate quite clearly that this method of diversified farming can be made profitable throughout the Southern States in regions where alfalfa can be grown successfully.

The average net profit per acre for the three years is $11.37. This is for the whole farm, including the Bermuda pasture, which was used very little. This, however, does not allow for any rent of land. If $3 an acre were deducted for rental, the profit would be cut to $8.37 per acre. While this might seem rather low on land valued at $150 to $200 an acre, still it is over 41 per cent on the $20 an acre valuation placed on the land described. It must also be remembered that during these three years more attention was given to increasing the fertility of the land and getting it in a good state of cultivation than to securing large yields. The work of increasing the depth to which the land is broken, plowing down the hillside ditches, etc., ad materially to the cost of production and correspondingly reduce profits. For example, alfalfa has been used in a short rotation, w allows it to stand only two years. While this suits the purpose s as soil improvement is concerned, it does not show to best advan the possibilities of alfalfa as a profitable hay crop. The returns fr field *B* in 1905, when a net profit of over $51 per acre was realized this field, give some idea of what may be expected when the p duction of alfalfa hay becomes one of the features of the farm. I was only the second year for the alfalfa on that field, and it w no doubt have given even better returns the third and fourth years

In connection with the alfalfa work, it has developed that brown and reddish brown soils are not nearly so well adapted to crop as the black and gray soils. As a rule, no trouble is experie in getting a stand on the latter soils, while it is frequently very cult to secure a perfect stand on the former. This is due in par the fact that crab-grass is persistent on the brown and reddish b soils.

It is to be regretted that weights could not have been tak show the actual gains made by the hogs while on the alfalfa pas While they throve and made good gains on this pasture, there a data to determine its actual value as a meat producer. The r for 1906, however, show that a well-set alfalfa field the second from sowing will furnish pasture for 12 to 15 head of hogs to th for six months—say, from the 1st of April to the 1st of October— at the same time produce 1½ tons of hay to the acre. Of course, hay were cut a few more animals might be grazed, but as the m improves the pasture this plan is to be preferred to pasturing en hogs to keep the alfalfa grazed close all the time.

One of the most interesting things brought out in the reco the corn production is the difference in the cost of cultivati hoeing under the different methods practiced. The first year the rows were laid out with the contour of the land and cult only one way, the cost of cultivation averaged $1.38 per acre a cost of hoeing 70 cents per acre. In 1905 and 1906, when th was check-rowed and cultivated both ways, the average cost tivation and hoeing was reduced to $1.10 and 21 cents, respect a saving of 20 per cent in the cost of cultivation and 70 per the cost of hoeing. Practically all the hoeing necessary uni check-row method was where the old hillside ditches hav Here the Johnson grass had gained a foothold and gave c able trouble.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 311.

AND-CLAY AND BURNT-CLAY ROADS.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF PUBLIC ROADS.
Washington, D. C., September 27, 1

SIR: I have the honor to transmit for your approval a manu containing the results of investigations made by this Office mixture of sand and clay for the improvement of roads, and the utilization of clay for road construction by burning. Most material contained therein has already been published in Bul. No. 27 of this Office, but the great increase in the demand for able information upon the construction of sand-clay and burnt roads makes the publication of a bulletin for wide distributio visable. I respectfully recommend, therefore, that this manu be published as a Farmers' Bulletin.

Respectfully,

LOGAN WALLER PAGE,
Dir

Hon. JAMES WILSON,
Secretary of Agriculture.

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Fig. 1. Clay mixed with sand to the point of saturation, with the angular sand grains in contact
2. Sand-clay mixture with an insufficient amount of sand, the grains not being in contact
3. Cross section of road, showing lumps of clay placed on a sand subsoil and covered with sand
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5. Cross section of road, showing clay cover on "deep" sand subsoil.

SAND-CLAY AND BURNT-CLAY ROADS.

INTRODUCTION.

Natural sand-clay roads may frequently be found in localities where the soil contains the right proportions of sand and clay. In sections of the country where the prevailing subsoil is composed entirely of clay, or, on the other hand, is of an extremely sandy character, these materials may be properly mixed so as to overcome as far as possible the objectionable features of each. The mixing of sand and clay as a form of road construction has received careful study and is of great importance, especially to the Atlantic and Gulf States, where throughout large areas sand and clay are practically the only materials available for road building.

One of the objects of this bulletin is to give some account of the commonly observed physical characteristics of clays and sands as an aid to the use of these materials for constructing roads. It must be remembered, however, that the great variation in the physical properties of clay makes it difficult to give definite rules, which shall be general in their nature, for the mixing and application of this material.

It may safely be said that the construction of sand-clay roads in the Southern States has passed the experimental stage. It has been proved that they are well adapted for light traffic, and are less noisy, less dusty, and more resilient than the average macadam road. Even under heavy traffic they have proved to a great extent satisfactory. There are sand-clay roads in the South Atlantic and Gulf States over which heavy loads of cotton and other farm products are hauled throughout the year, with but little resulting damage. When the cheapness of this kind of construction is considered, it will be seen that for certain localities, at least, it is preferable to macadam. In all cases a mixture of sand and clay is better than either material alone, except perhaps where it is impossible to drain a sandy road, and, in consequence, it is always wet. Very little, if any, clay should be used in this case, for the water acts as a binder and the sand remains firm.

In some sections of the country the only available material from which roads can be constructed is clay. To meet this condition the Office of Public Roads has made experiments in the so-called "gumbo" district of the lower Mississippi Valley, in burning the clay along the entire length of the road. By burning clay, even a moderate heat, its well-known sticky or plastic quality is destroy so that even in the wettest weather it will bear traffic. If the clay fired along the entire length of the road, the cost of hauling it avoided, and at the same time the advantage is gained of burning the foundation of the road as well as the material to be placed upon it.

PHYSICAL PROPERTIES OF SAND AND OF CLAY.

The mineral known as quartz, which is composed of silica, is fou abundantly in all parts of the earth. When consolidated by heat an pressure into great masses of rock it is known as quartzite, and also appears as an important constituent of many different kinds rock. When quartzite is disintegrated by the action of the elem and is found in great loose masses, composed of fine and more or uniform grains, it is known as sand. It is a well-recognized fact th sand lacks binding power, and on drying out is of a loose and unsta nature.

Clay, on the other hand, is formed by the decomposition of ot minerals which go to make up the structure of rocks. The origi all clay is the mineral feldspar, which, under the action of water, h been gradually leached out and changed into clay. The particle clay are usually much finer than those of sand and are frequently c ried by running water some distance from the point at which were originally formed, where, having settled as a sediment on bottom, they form deposits which are known as sedimentary cl In some cases where huge deposits of feldspathic rock have been di tegrated and changed by the action of water in place, the dep are known as residual clays.

It will be seen from this that clays must vary both in texture composition. Some will be found to contain as much as 75 per of sand, while others are extremely fine in texture and entirely w out grit. As would be expected, the sedimentary clays are us finer and more sticky and plastic than the so-called residual cla

The two properties of clays which are of the greatest impor from the standpoint of road building are, first, plasticity, and the property of slaking when they first become wet after having uncovered. A clay is called plastic which becomes sticky or do like when mixed with a certain amount of water, so that it ca molded or pressed into various shapes which it will retain even it has been dried. The most plastic of these materials are kn technically as "ball clays." If a lump of such a clay as th immersed in water it will usually preserve its form for a long p

There are other clays, however, which will immediately f pieces, as a lump of quicklime will do under similar conditions.

known to be due to the very rapid absorption of water into the
rous structure of the clay. It will easily be seen that this charac-
·istic is an important one from the standpoint of the road builder,
r any sort of agitation will cause a large percentage of a slaking
y to pass into suspension in water and form a thick mud. Non-
king clays, although they are very sticky when wet, do not so read-
mix with water. It stands to reason that the slaking clays are
ıally "deep seated," that is to say, they will be found below the
face of the ground. Slaking clays are more easily mixed with
ıer materials than the more plastic ball clays, and this is, of course,
their advantage for road building. On the other hand, they are
en of inferior binding power.

There is still another physical characteristic of clay that is of great
portance from the standpoint of road building. Some clays shrink
en dried, which leads to the cracking and breaking up of their
faces. This shrinkage is the measure of their expansion, and
ansion renders the sand-clay composition unstable. Shrinkage
ıld do no harm if the clay would stay in this condition, but this it
s not do. When water, removed by evaporation, is restored to
sand-clay mixture, its entrance is accompanied by a simultaneous
ansion which causes the grains of sand to be separated. This
perty can not be overcome, for it is inherent in the clay, but we
in some measure modify its effect by using less clay in the com-
ition. This, however, will weaken the road and dispose it to break
in dry weather.

efore attempting to construct a sand-clay road it is best to test
material in the neighborhood in order to secure a clay having the
t possible shrinkage. There is no better way than to examine the
eled roadways. In almost every community there are short sec-
s of natural sand-clay road which may be examined.

THE MIXING OF SAND AND CLAY.

he best sand-clay road is one in which the wearing surface is com-
d of grains of sand in contact in such a way that the voids or
ılar spaces between the grains are entirely filled with clay, which
as a binder. Any excess of clay above the amount necessary to fill
voids in the sand is detrimental. If a small section taken from
urface of any well-constructed sand-clay road is examined with a
nifying glass, the condition of contact which exists between the
ns of sand and the small proportion of clay which is required to
he voids may be seen. Wherever this proper condition of contact
s for a few inches in thickness upon the surface of a road, it will
comparatively heavy traffic for a long time, even when the sub-

soil is sand or clay. The proper mixture or saturation point of clay and sand can easily be seen by referring to figure 1.

All the experiments that have been made by this Office indicate that the materials should not be mixed in a dry state, but that they should be thoroughly mixed and puddled with water. It makes little difference by what method the stirring or mixing is done, so long as it is thorough and proper proportions of the materials are obtained. If an excess of clay is used in the mixture, as shown in figure 2, the grains of sand which are not in contact are free to move among and upon each other, so that no particle exerts more resistance to pressure than if the entire mass consisted of clay alone. On the other hand, if an insufficient amount of clay is used, the mixture will lack binding power and will soon disintegrate.

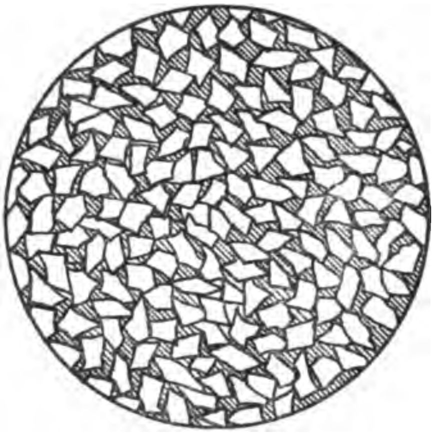

FIG. 1.—Clay mixed with sand to the point of saturation, with the angular sand grains in contact.

We may now outline the methods which have been used to obtain the proper contact mixture, although it will be necessary to discuss separately the methods of treating slaking and nonslaking varieties of clay. It will readily be seen that it is less economical to haul sticky or plastic clay and spread it upon sand than it is to haul sand and spread it upon clay. The clay is difficult to dig and handle and usually comes out in lumps, which, if placed upon the roadbed and covered with sand, are apt to remain unbroken unless great care is taken in the mixing. The bad effects of lumps of clay in a sandy subsoil and the effects of traffic on such a mixture are illustrated in figures 3 and 4.

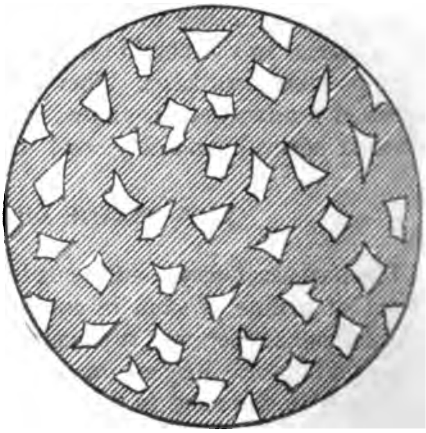

FIG. 2.—Sand-clay mixture with an insufficient amount of sand, the grains not being in contact.

Figure 3 shows a cross section of a road into which lumps of clay have been worked. Figure 4 shows the displacement of these lumps when subjected to the prolonged action of traffic, and the resulting formation of deep ruts and general disintegration of the surface.

It has been pointed out that thorough stirring and puddling are absolutely essential to successful sand-clay construction. This is most easily brought about immediately after a hard or prolonged rain, the clay having been previously spread and the larger lumps broken up as completely as possible. The surface should then be covered with a few inches of sand and plowed and harrowed thoroughly by means of a turning plow and a cutaway or disk harrow. This stage of the work will of course be found somewhat disagreeable, leading, as it does, to the formation of a thick, pasty mud; but it is the only practicable way in which the necessary mixing can be accomplished. Many experiments have been tried with dry mixing of the clay and sand, but all have been more or less unsuccessful. In cases where the plowing and harrowing are considered too expensive the mixing may be left to traffic. This, however, inevitably leads to a muddy road surface for a long time, although finally it is possible, by a proper distribution of the sand upon the clay, to bring about a fairly good result, even by this simple method.

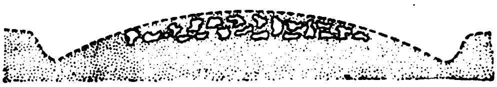
FIG. 3.—Cross section of road, showing lumps of clay placed on a sand subsoil and covered with sand.

In case a slaking clay is used, very much less puddling is required, as there are practically no lumps to be broken up and the mixing can easily be done with a harrow after a rain. Slaking clays do not usually make as effective binders as the more plastic clays; therefore in dry weather the road surface becomes more dusty. It will be seen that the best clay for this kind of construction is one which slakes sufficiently easily to enable the lumps to be readily broken up, and which at the same time, without being too plastic, has sufficient binding power to cement the grains of sand and form a smooth, impervious surface on the road. Clays of this nature which have given excellent results are found in abundance in many of the Southern States and doubtless exist elsewhere. Their color is usually red or mottled red and white. Occasionally clays are found sufficiently sandy to be suitable for use without further mixing. When this is the case it is only necessary to spread the material on the road and allow it to pack under traffic. It is obvious that it is necessary to pay careful attention to the physical

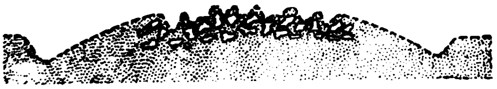
FIG. 4.—Cross section of road, showing displacement of lumps of clay when subjected to travel.

properties of the available clay in the neighborhood of the road. will frequently be found economical to haul good material for distance rather than to use an inferior material which is close at h The qualities to be considered, as has been pointed out, are the gr est binding power obtainable, together with the least amount of l necessary for disintegrating and mixing.

APPROXIMATE METHOD FOR ESTIMATING THE PROPER PROPO TIONS OF SAND AND CLAY.

It has already been shown that the best mixture for sand-clay struction is one in which there is just enough clay to fill the void the sand, thus producing the proper cementing bond in the road face. No exact rules can be laid down for calculating in advance best mixture. It must be remembered that the relation of weight volume will vary widely in different clays, according to the am of water which they contain. Some clays, especially the more pl varieties, even after they are as thoroughly dried as they can be hottest summer sun, will still hold as much as 20 per cent of w This water is known to chemists as "water of combination," be it seems to be either combined with or held in the structure of clay particles in such a way that it can only be driven out at a temperature. It is apparent from this that in handling a clay this kind, even when it seems quite dry, each ton will contain pounds of water which does not enter into the consideration of ume. The amount of clay necessary to fill the voids in any sand will therefore be found to vary.

An easy method for making a rough or approximate estimate volume of the clay filler required for any unit quantity of a given is as follows: Two ordinary glass tumblers of the same size are to the brim, one with the dry sand to be tested and the other water. The water is then poured carefully from the one glass the sand in the other until it reaches the point of overflowing. volume of water removed from the glass which was originally f water can be taken as an approximate measure of the voids unit volume of sand contained in the tumbler. A simple calcul will reduce this to percentage volume.

Practical experience has shown that the tendency is to calcula little rather than too much sand for given amounts of clay, and invariably a second and even a third application of sand is nec over and above the calculated amount. It often happens that will work up to the surface under the action of traffic, in which an extra top dressing of sand should be added when required.

METHODS OF CONSTRUCTING A SAND-CLAY ROAD.

In passing to a detailed description of methods of construction, it must first be stated that there are two distinct conditions which are likely to be met. In the first case the road may have a sandy subsoil, ordinarily spoken of as " deep " sand, the objectionable features of which must be overcome by the addition of clay. On the other hand, the subsoil may be of clay, and in this case sand must be added to it. Since there is a radical difference in the methods of construction in these two cases, each will be treated separately.

DRAINAGE.

In all forms of road construction the most important consideration is that of drainage. If natural drainage does not exist, artificial methods must be used. The best natural drainage is usually found upon a loose gravel or a sandy soil, especially when the grade of the road is somewhat above the surrounding country. If the land is dry and the sand deep enough to absorb quickly even the heaviest rains, no special attention need be given to drainage other than to provide the proper crown to the surface of the finished road to divert the water from it. Frequently, in tide-water regions, the country is so low and level that the surface of the road is likely to be kept continually wet from seepage. If this condition has to be met, it is necessary to dig wide ditches on each side of the roadbed and raise the grade so that the crown of the road will be sufficiently high to shed water thoroughly before hauling any clay upon it.

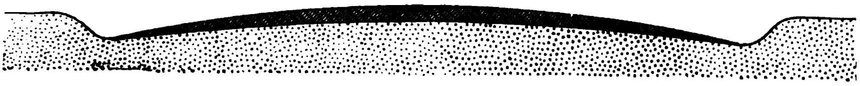

FIG. 5.—Cross section of road, showing clay cover on " deep " sand subsoil.

It is very important that no stumps or branches of trees or other matter subject to decay should be overlooked and left in the roadbed, as at such points weak places are sure to be developed in the course of time. Although natural drainage is much better on sandy subsoils than on clay, in clay districts the conformation of the country is more likely to be of an undulating or rolling character, thus furnishing a natural watershed. Temporary or so-called " wet-weather " springs are not so likely to occur in sandy soils as in clay soils, and therefore need not be so carefully guarded against. Nevertheless, if any indications of these springs are found, precautions should be taken to conduct the water to the side ditches by some form of underdrainage.

SAND-CLAY CONSTRUCTION UPON A SANDY SUBSOIL.

When the drainage has been properly provided, the roadbed should be brought to a crown. It has been found more economical to first a section of the road nearest the source of the clay. The first load of clay is dumped on this prepared section at the point nearest the clay bed, each succeeding load thus being hauled over the preceding. Care should be taken to spread each separately and evenly as soon as it has been deposited and before it is driven over. The clay cover spread upon the subsoil is shown in figure 5.

After spreading the clay it should be covered with a layer of clean sand. When the road has been opened to traffic a sufficient amount of sand should be added from time to time to keep the surface smooth and prevent the formation of mud. Both the thickness and the width of the layer of clay to be spread are determined by the volume and character of traffic which the road is to sustain. If a narrow, single-track roadway is to be built, it has been found best to spread the clay to a width of about 12 feet and to a depth of 6 to 8 inches in the center, tapering the layer to a thin edge at the sides. In some cases it may be necessary to modify these directions to accord with the quality of the clay and the amount of sand which it contains. The "leaner" or more sandy the clay, the greater will be the amount required.

After the clay layer is completed and covered with sand, as already stated, if the clay is of a plastic and lumpy character it will probably be necessary to plow and harrow it alternately until the lumps are thoroughly disintegrated. Advantage should be taken of rains in order to puddle the road surface with a harrow. As long as the surface shows a tendency to "ball" and cake, more sand must be added until this trouble is overcome. If, on the other hand, the surface loosens in dry weather, it is due to an insufficient quantity of clay or else because the clay lacks binding power. It must be borne in mind that the construction of a sand-clay road is not a quick operation, but a process of rather slow development. In the course of the work there is time to determine what proportions of the two materials will finally lead to the best results.

If the materials are especially adapted to the purpose it is possible to construct very excellent sand-clay roads without the use of plow, harrow, or roller. The mixing can be left, after the materials have been properly spread, entirely to the action of traffic. In all construction, however, the best results are hastened by the use of plow and harrow. In all cases it is advisable to use a road machine or other similar implement to crown and smooth the surface, after which a light coat of sand may be added.

The quantity of clay required to build a mile of road will vary of course with the width and depth of the clay layer. A roadway 12 feet wide with an average depth of 6 inches of clay will require a cubic yard of clay to cover 4½ feet of road length; that is to say, each cubic yard of clay will make 1½ " running " yards of clay road. Since there are 1,760 yards to the mile, it will be seen that 1,173⅓ cubic yards of clay will be required for 1 mile of construction. From this data the cost may be readily calculated, when the rate of wages and distance of haul are known. The average load has been found to be about two-thirds to three-fourths of a cubic yard, when the hauling is done over sand, and about 1 cubic yard when the hauling is done over a dry clay road. It may be said after rough calculation that a 2-horse load of clay will cover 1 linear yard of 12-foot surface, making 1,760 loads to the mile. The cost of shoveling sand upon the clay is the same, whether the mixing is to be done with a plow and harrow or left to traffic, and should therefore in each case be added to the cost of hauling.

SAND-CLAY CONSTRUCTION UPON A CLAY SUBSOIL.

After proper drainage has been provided the roadbed should first be crowned as nearly as possible to the form desired in the finished road. The road surface should slope from the center to the sides at least one-half inch per foot. It should be noted that it is much more important to form this foundation crown first where the subsoil is of clay than it is with a sandy subsoil.

The foundation having been properly prepared, the surface should be plowed and harrowed to a depth of about 4 inches until it is pulverized as completely as possible. It is then covered with 6 to 8 inches of clean, angular sand. The sand should be spread so that the layer is thickest at the center of the road, following in general the same plan as was outlined for spreading clay upon a sandy foundation. The materials should then be mixed while they are in a comparatively dry state, contrary to the usual practice of doing the entire mixing and puddling when the materials are wet. It has been found that the clay foundation can be more evenly disintegrated when comparatively dry, and it is also a difficult matter to mix the sand evenly with the clay if the latter is soft and cut into ruts by travel. This preliminary mixing should be done if possible, but often conditions do not allow it and the sand has to be mixed on the wet clay road. After this first mixing has been finished the road is finally puddled with a harrow after a rain. In case an excess of clay works to the surface and tends to make the mixture sticky, sand should be applied until this trouble is overcome.

Upon the completion of the mixing and puddling, the road should be shaped while it is still soft enough to be properly finished with a scraper and at the same time stiff enough to pack well under the roller or under the action of traffic. In case it is impossible to obtain the proper consistency of the surface material, it is better to [illegible] the road when somewhat too wet than when it is too dry, [illegible] necessary to stop traffic upon it for a few days. The road shou opened to traffic as soon as practicable after completion, as thi be found to have a beneficial effect upon it.

After sand-clay roads are constructed, they should be car until the proper condition is established and the road is resista traffic. This care is extremely important and is deserving of sp mention. No sand-clay road is in proper condition when firs structed, and this attention afterwards is as much a part of th construction as the hauling of the first load of sand or clay.

COST OF SAND-CLAY CONSTRUCTION.

It is of course impossible to state definitely the cost of this of construction, as it will be found to vary with the price of lab length of haul, the width of roadway, and depth and nature of terial. If we assume, however, that the clay can be procured w a mile of the road which is to be improved, and that the cost of is about $1 per day and teams $3 per day, the cost of construct 12-foot sand-clay road on a sand foundation, covered with clay average depth of 6 inches, would be approximately as follow distance of 1 mile:

Crowning and shaping road with road machine, using 2 teams at $3 and 1 operator at $1.50 per day for 1 day	
Loosening 1,173⅓ cubic yards of clay with pick and shoveling into wagons at 15 cents per cubic yard	
Hauling 1,173⅓ cubic yards of clay, at 23 cents per cubic yard	
Spreading clay with road machine, using 2 teams at $3 and expert op erator at $1.50 per day for 3 days	
Shoveling sand on clay, estimated at ½ cent per square yard	
Plowing, using 1 team at $3 per day for 4 days	
Harrowing, using 1 team at $3 per day for 2 days	
Shaping and dressing with road machine, using 2 teams at $3 and expert operator at $1.50 per day for 2 days	
Rolling, estimated at ½ cent per square yard	
Total	

The estimated cost per square yard of road surface, the when computed on the basis of this table, would be about 8 cen at the rate of $579.26 per mile.

The cost of building a sand-clay road on a clay foundation w not vary much from the figures given. The latter form of co tion would probably be slightly cheaper by reason of the fac sand can be handled more economically than clay.

According to the experience of this Office, the cost of sand-clay struction in the South has been found to range from $200 to per mile, in most cases running from $300 to $800. A sand-cla constructed under the direction of the Office at Gainesville, F ile in length, 14 feet wide, and having a 9-inch sand-clay surface, st $881.25 per mile, or 10 cents per square yard. Another sand-clay ad built under the direction of the Office at Tallahassee, Fla., 16 et wide and surfaced with about 7 inches of sand-clay mixture, cost 70 per mile, or about 5 cents per square yard. In case changes of ade have to be made with consequent cuts and fills, the cost would proportionately greater than the figures given above. There can no question, however, that under all circumstances this form of nstruction is cheaper than macadam.

THE USE OF SAND-CLAY ROADS IN THIS COUNTRY.

The possibilities of the sand-clay road may not be fully realized the public for a long time to come, still the progress being made in is form of road building in nearly every part of the country is couraging. Such benefits as have come to Richland County, S. C., ke County, Ala., Dallas County, Ala., Cumberland County, N. C., d many other sections throughout the Atlantic and Gulf States om the use of sand-clay roads should be a sufficient incentive for a neral study of the subject in those parts of the country where these iterials exist in adequate quantities.

Sand and clay had always been abundant in Pike County, Ala., ll a combination of the two for road purposes was not thought of til four years ago. At the present time there are nearly 120 miles sand-clay road in this county, which for all practical purposes, e as useful as macadam roads, and which have cost about one-sixth the amount standard macadam of the same or less width would cost this section. With this system the remotest section of the county y be reached, which would not be the case had fewer and more pensive roads been attempted. At the present rate of improvement ery important public road in this county will soon be a serviceable ghway, over which a wagon loaded with six bales of cotton may be awn easily and quickly, whereas, before the improvement began, ly small loads were possible. It is important that success like this ould be given wide publicity because it carries with it method as ll as encouragement. The first thing done in this locality was to d out which of the clays accessible would make a good road. ter this important matter had been decided, bonds were issued to ise money to buy equipment. This comprised eight outfits of rteen to sixteen mules each, wagons, plows, scrapers, and hand ls.

The extent to which this form of road construction can be used in blic road improvement throughout the country can hardly be overimated. In making small repairs to roads, if, instead of filling idholes with brush, a few loads of sand or gravel from sand bars d gravel beds found along the streams in hilly portions of the country were hauled to the road, permanent improvement w result.

It has been found that this kind of road is admirably suited t northwestern part of the country as well as to the southern. It is believed that it will be found worthy of more general study t it has ever received heretofore. Its study should be of interest t public schools in the rural districts of the country. If school were encouraged to make a sand-clay walk to the schoolhou teacher's task of keeping a clean school building would be suffic lessened to make up for the time taken to interest the boys. Be this actual improvement, a lasting benefit would be given to that munity from this simple study of a valuable process. For a part of the country, the sand-clay road is the only road possib within the reach of the rural districts. It requires less mon build than any other type of road except the earth road an money to repair. It is simpler in its construction than any except the earth road, and lasts longer with the same amoun repair.

THE CONSTRUCTION OF BURNT-CLAY ROADS.

In large areas in the South, particularly in the valleys of the M sissippi and its tributaries, sedimentary clays are found very g ally. In these areas there is little or no sand, and the clays are particularly plastic and sticky variety. These sticky clays are lo known as "gumbo" and "buckshot." In such localities tra absolutely impossible during the wet season, as the wheels of h vehicles will sink to the hub. In order to overcome this difficult Office of Public Roads undertook an investigation of the m Special experiments were carried on in the laboratory to see could be done in the way of burning or clinkering these clay not only to destroy their plastic qualities, but also, as far as pos to form hard, brick-like lumps which should be capable of sus traffic. Samples of the material were sent from the Yazoo distr Mississippi to the laboratory, and the clinkering point of the cla found to be sufficiently low to indicate that simple burning lumpy clays upon the road surface by means of open wood fires accomplish the desired result. Following these laboratory ex ments it was decided to make experiments on a road, and it c stated that this experimental road is proving highly satisfactor

Gumbo clay is black, owing to the high percentage of orga vegetable matter it contains. It is particularly sticky in its na and is almost wholly free from sand and grit. After it ha burned, however, the plasticity is entirely destroyed, and a clinker is formed which, though not particularly hard, when p ized forms a smooth surface and seems to wear well. It shou understood that not all of the clay out of which the road is to be constructed is to be clinkered, but only a sufficient amount should be rendered nonplastic to neutralize the too sticky character of the native clay. Fortunately the gumbo district is plentifully covered with heavy timber, thus affording an abundance of fuel. Work should be done in a dry season of the year.

While the only experimental burnt-clay roads constructed by the Office are in Mississippi, the same methods might be applied with equally good results in the sections of the prairie States that have no other material available for road building and have sufficient timber for this purpose.

FUEL.

Good sound wood, as dry and well seasoned as it is possible to procure, should be provided before beginning the work, and stacked at convenient intervals along the side of the road. About 1 cord of wood has been found necessary for 8 linear feet of roadbed 12 feet wide. The wood may be cut to 4, 8, or 12-foot lengths. Brushwood, if it is dry, or chips, bark, old fence rails and discarded railroad ties, coal slack—in fact any sort of fuel that can be easily and economically obtained—may be used to advantage with the cord wood.

PREPARATION OF THE ROADBED.

After grading the road to an even width between ditches, it is plowed up as deeply as practicable. It will be found necessary to use four horses or mules, as the extremely heavy nature of the clay makes the work of deep plowing difficult. After the plowing has been completed, furrows are dug across the road from ditch to ditch, extending through and beyond the width to be burned. If it is intended to burn 12 feet of roadway, the transverse furrows should be 16 feet long, so as to extend 2 feet on each side beyond the width of the final roadway. Across the ridges formed between these furrows—which should be about 4 feet apart—the first course of cord wood is laid longitudinally so as to form a series of flues in which the firing is started.

The best and soundest cord wood is selected for this first course and should be laid so that the pieces will touch, thus forming a floor. Another layer of wood is thrown irregularly across this floor, in crib formation, with spaces left between in which the lumps of clay are piled. Care should be taken that the clay placed on this cribbed floor is in lumps coarse enough to allow a draft for easy combustion.

After the lumps of clay have been heaped upon this floor, a third course of wood is laid parallel to the first. This third course is laid in exactly the same manner as the first, and each opening and crack should be filled with brush, chips, bark, small sticks, [illegible] combustible material. The top layer of clay is placed [illegible] the finer portions of the material are heaped over the whole structu A careful arrangement of this cord-wood cribbing to separate the cla is important, and the directions should be carefully followed.

The deep covering of clay which is thrown over all should be tak from the side ditches, and may be in lumps of all sizes, including th very finest material. It is spread as evenly as possible over the top a layer of not less than 6 to 12 inches. Finally the whole is tamp and rounded off so that the heat will be held within the flues as lo as possible. When coal slack is available the two top layers of w may be omitted and the coal slack thoroughly mixed with the m of clay.

It is necessary to get the fires well under way in the flues befor first layer of wood is burned through. The first action of the fir to drive out the water contained in the clay before the actual bur and clinkering can begin. In burning the gumbo clays a great adv tage is gained from the organic and vegetable matter which is c tained in the clay, as that in itself aids combustion.

FIRING.

When the roadbed has been carefully prepared according to foregoing directions, the firing should begin. In our practice 20 flues are prepared for firing in one section. If, however, a la force of laborers is available for the work, a greater number of fl can be fired at one time. It is always possible to divide the fir into sections by omitting the charge of wood in one transverse row, which may then be covered later and burned in the same way the rest.

The best results are obtained by firing all the flues of a se simultaneously and maintaining the combustion as evenly as pos A supply of light, dry, kindling wood, or any easily inflammable terial, should be at hand to prevent the fire from dying down in one place. The firing should invariably be begun on the windw side, in order to obtain the maximum draft. In case the combus is too rapid in any flue it may be regulated by banking the mout the flue with clay.

If the burning is entirely successful, not only the portion of which forms the top of the kiln but the ridges between the flue be burned thoroughly, so as to form a covering of burnt clay 10 inches in depth, which, when rolled down and compacted, for road surface of from 6 to 8 inches in thickness. If properly bur the material should be entirely changed in character, and when wet it should have no tendency to form mud.

When the material is sufficiently cooled the roadbed shou brought to a high crown before rolling, in order to allow for compacting of the material. This can best be done with a plow or a grader. After this the rolling should be begun and continued until the roadbed is smooth and hard. The finished crown should have a slope of at least one-half inch to the foot.

The main advantages of this method of burning a road over its entire length are, first, that the cost of transporting the clay is avoided; second, that the subgrade of the road is burned as well as the material above.

COST OF BURNT-CLAY CONSTRUCTION.

It is, of course, impossible to give the cost of a burnt-clay road which will apply to the same work in all sections of the country. Although this form of construction in the South up to the present time has been successful, it can not as yet be said to have passed the experimental stage. The items of cost of the experimental road 300 feet long, as constructed at Clarksdale, Miss., are as follows:

30½ cords of wood, at $1.30 per cord	$39.65
20 loads of bark, chips, etc	6.00
Labor, at $1.25 per day, and teams, at $3 per day	38.30
Total cost of 300 feet	83.95
Total cost per mile at this rate	1,478.40

In view of the success of the experiments so far made and the comparative cheapness of this form of construction, it is hoped that the localities which have no hard material available will continue the experiments with burnt clay. Although it can not be denied that the gumbo and buckshot clays of the South are particularly adapted for burning on account of the high percentage of organic matter which they contain, it is none the less probable that many of the surface clays and soils of the States farther north could be treated in the same way, and in fact any soil or clay which bricks or clinkers at a comparatively low temperature should be suitable for the work.

Since the experiment made by this Office at Clarksdale, Miss.,[a] numerous sections of burnt-clay road have been built in that locality, and up to the present time only favorable reports regarding them have been received. Experimental burnt-clay roads are now (1907) being constructed under the supervision of this Office at Indianola, Miss., and at Greenville, Miss., but since the work at these places is still incomplete no report upon it can be given.

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[a] For reports concerning this road, see Annual Report, Office of Public Roads, 1905.

FARMERS' BULLETINS.

The following is a list, by number, of the Farmers' Bulletins available for distribution. The bulletins entitled "Experiment Station Work" give in brief the results of experiments performed by the State experiment stations. Titles of other bulletins are self-explanatory. Bulletins in this list will be sent free to any address in the United States on application to a Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C. Numbers omitted have been discontinued, being superseded by later bulletins.

22. The Feeding of Farm Animals. Pp. 40.
24. Hog Cholera and Swine Plague. Pp. 16.
25. Peanuts: Culture and Uses. Pp. 24.
27. Flax for Seed and Fiber. Pp. 16.
28. Weeds: And How to Kill Them. Pp. 30.
29. Souring and Other Changes in Milk. Pp. 22.
30. Grape Diseases on the Pacific Coast. Pp. 15.
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33. Peach Growing for Market. Pp. 24.
34. Meats: Composition and Cooking. Pp. 31.
35. Potato Culture. Pp. 24.
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54. Some Common Birds. Pp. 48.
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60. Methods of Curing Tobacco. Pp. 24.
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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 312.

A SUCCESSFUL SOUTHERN HAY FARM.

BY

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Assistant Agriculturist, Farm Management Investigations,
Bureau of Plant Industry.

WASHINGTON:
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1907.

LETTER OF TRANSMITTAL

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., October 23, 1907.

Sir: I have the honor to transmit herewith a paper entitled "A Successful Southern Hay Farm," by Mr. Harmon Benton, Assistant Agriculturist, prepared under the direction of the Agriculturist in Charge of Farm Management Investigations of this Bureau.

While this paper is an exceedingly interesting one as showing the possibilities of a small area of land in the South, it should be understood that the conditions under which the farm in question was managed were unusual. As pointed out in the paper, it would not be possible to duplicate in many places the prices for hay received by the owner of the farm in question. There are many sections of the South, however, where hay would sell at a handsome profit, and the adoption of the systems of management set forth in these pages would be of material advantage in building up the soil. The suggestions and recommendations made are certainly worthy of consideration, and I therefore recommend that the paper be published as a Farmers' Bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—316.

A SUCCESSFUL SOUTHERN HAY FARM.

INTRODUCTION.

In localities where a one-crop system has prevailed for a number of years farms which deviate from this system are of special interest, because they show what types of farming are possible in the section in which they are located. In the cotton-growing States such farms are of unusual interest for the reason that so few of them exist. Much of the hay consumed on Southern farms and plantations is shipped from the North. As a result, hay is high priced in the South. There is room for a considerable number of hay farms in that section. That such farms can be made to pay handsomely is demonstrated by the experience of the farmer whose work is described in these pages.

Not every hay grower can follow the methods here described. It is not necessary, however, that a farmer should feed steers for their manure, as is done on this farm, in order to be able to grow hay. While nothing else is quite equal to manure, land can be kept in good heart by plowing under an occasional green crop and then using lime and commercial fertilizers.

A brief discussion of hay growing under more usual conditions on southern farms will be found at the end of this bulletin.

LOCATION.

Eight years ago Dr. D. S. Ramseur, of Cherokee County, S. C., purchased a run-down cotton farm in the Piedmont region, 25 acres of which he has placed under the mangement described below. At hat time the land would not produce more than one-fourth bale of otton to the acre, with 250 pounds of fertilizer. Now the land is yielding more than $50 an acre annually, with less labor than cotton would require. Besides, it is improving in fertility.

The soil varies from a pebbly clay to a sandy loam.

MANAGEMENT.

Under the present management the value of the farm has been reatly enhanced. To illustrate: Doctor Ramseur purchased a few acres of land from an adjoining neighbor in 1906 at $16.66 per acre. At the same time the neighbor offered $100 per acre for the adjoining portion of Doctor Ramseur's farm. It is interesting to note that the difference in value of these two farms has been brought about by difference in soil treatment in eight years' time; besides, profitable crops of hay have been removed from the land every year.

The management of this farm is of interest to every cotton grower and every tobacco grower. At the time the farm was purchased it was terraced according to the usual custom in cotton fields in that section. By the plan followed the objectionable terraces have been removed and the soil has been greatly increased in fertility and in value. The effect of torrential rains is not so great in washing out gullies, owing largely to the fact that the land is covered with some growing crop all the time and to the addition of organic matter to the soil. The methods used by Doctor Ramseur can be applied to at least a small portion of many southern farms and plantations.

For the first few years the crops on the farm here described consisted of oats in winter, cowpeas in summer for hay, and a sufficient acreage of corn to supply the farm. The application of barnyard manure and the turning under of oat and cowpea stubble made it possible to grow crimson clover, and that crop now occupies an important place in the cropping system and has proved to be most valuable.

No commercial fertilizers have been used on the farm since the present owner bought it. A dressing of 6 to 8 tons of barnyard manure per acre is applied annually. This manure is obtained from feeding beef cattle at the owner's home, one-fourth mile from the farm. The beef cattle are natives, fattened for the local market on cotton-seed meal and hulls. The feed is mixed in the proportion of 1 pound of meal to 5 of hulls. Twenty-five pounds of the mixture are fed per day per 1,000 pounds live weight. An average of 25 animals is kept constantly on hand; these are sold to butchers as demanded by the local market.

No accurate accounts are kept of the feeding operations, but it is estimated that the increase in live weight and the advance in price of fat cattle over poor ones pay for the food and the time consumed in feeding, leaving the manure as profit.

The animals are fed the same summer and winter under a large shed surrounding the main barn. Feed and water are placed in separate troughs, and the animals eat and drink at will.

The principal part of the work on this farm is performed by one man and one horse. Additional help in the way of teams and men is used during the harvest season. The owner informed the writer that the horse and man did enough "outside work" to pay for the extra help during the harvest season.

During the winter of 1905 the crops consisted of 18 acres of oats and 7 acres of crimson clover. In the spring of 1906, 3 acres of the land that was in crimson clover the preceding fall were planted in corn, the remaining 4 acres of clover land and the 18 acres of oat land being sown broadcast to cowpeas. No regular rotation of crops has been practiced, owing to the fact that the acreage of corn has been decreased as the land increased in yield and that variation of seasons causes the area of crimson clover planted to be variable. The idea is to get over the entire farm with crimson clover as often as possible.

Corn follows a portion of the clover in the rotation, neither being planted two years in succession on the same land, except in the case of crimson clover following corn. By this system corn and clover gradually rotate over the entire farm. More years are required for corn than clover, as it occupies less than one-half the land now planted in clover. Corn always follows early plantings of crimson clover after cowpeas. This system enables the owner to secure two crops a year from the land: Fall crops, clover and oats; spring crops, corn and cowpeas.

It is quite probable that if vetch seed were sown with the oats better results would be secured. The land is now in condition to produce good vetch. This plant would add to the quality and quantity of oat hay produced and at the same time supply a winter legume. This combination was tried in a small way in the fall of 1906. At the suggestion of the writer the same combination will be tested on a larger scale in the autumn of 1907. By planting vetch with oats two crops of leguminous plants can be secured from the same land every year—oats and vetch and crimson clover in winter and cowpeas in summer.

Cotton is never grown on this farm, as it costs too much in proportion to the amount received for the product.

German millet has been successfully tried, but it is not a satisfactory crop on this farm. Its season is not quite the same as that of cowpeas and it does not fit into the system of growing two crops a year. Farther north, where it can be sown later, it would do this.

Doctor Ramseur does not like sorghum as a hay crop. He considers the yield satisfactory, but it can not be baled and put on the market in a satisfactory condition because it is impossible to dry it sufficiently to prevent the juice from breaking out of the stems when it is baled. This objection would not hold on farms where the sorghum hay is fed at home and where, consequently, it does not need [illegible] baled.

CULTURAL METHODS.

CRIMSON CLOVER.

Crimson clover always follows corn and as much of the cowpea land used for early cutting as can be properly prepared for planting before November 1. Clover seed is sown in the corn at the last plowing and on cowpea land as soon as possible after the removal of the earlier cutting of cowpeas for hay. On corn land the clover is sown at the rate of 20 pounds per acre and cultivated in at the last working of corn. After the cowpeas are harvested the land is plowed as well as possible with a one-horse turning plow. Afterwards it is harrowed into good condition. On cowpea land also the crimson clover seed is sown at the rate of 20 pounds to the acre, but is harrowed in lightly.

Doctor Ramseur prefers to plant crimson clover in August and September. He never plants it after November 1, because the young plants are frequently injured by winter freezing, and besides the growth is unprofitable when planted later. After sowing all the crimson clover possible the remainder of the land is sown to oats.

The earlier plantings of crimson clover are ready to cut for hay about May 10. The hay is allowed to remain in the swath until thoroughly wilted. It is then raked into windrows and allowed to remain until quite well cured, after which the hay is thrown into small, tall cocks, where it remains until thoroughly cured. After being cured the hay is drawn to a large shed in the field, where it is allowed to remain until the owner is ready to put it into bales.

From practical experience extending over a period of about four years Doctor Ramseur states that crimson clover should not be cut for hay while too green. He lets about two-thirds of the flowers dry on the seed head before cutting. He states that he practically lost one crop by cutting too green. "If cut when in full bloom it takes much longer and is more difficult to cure." On the other hand, this crop should not be cut too ripe. If allowed to stand much longer than the early flowering stage, the beards of the calyx form "witch balls" in the stomachs of stock eating the hay, sometimes with fatal results.

Doctor Ramseur considers the stubble of a good crop of crimson clover, when turned under, far superior to cowpea stubble.

The yield of crimson clover in 1906 was 3,500 pounds (1¾ tons) of cured hay per acre.

OATS.

After November 1 the portion of the farm that can not be planted to crimson clover is gradually prepared as well as possible with a one-horse plow, and a variety of oats known as the Appler is drilled in at the rate of 2 bushels to the acre. The open-furrow system is practiced in planting oats, i. e., rather deep furrows are laid off 15 to 18 inches apart, and the oats are planted with a one-horse planter in the bottom of these furrows. In this section oats frequently " heave " during the winter when planted on the level, but if planted in these furrows particles of soil from the sides of the furrows are loosened by freezing and recover the roots of the oats as they are " heaved " out of the soil.

Oats are planted, as previously stated, over the whole area not planted in crimson clover. In 1906 the 18 acres planted averaged 3.000 pounds of cured hay per acre. The oats are cut for hay while in the dough stage. Doctor Ramseur states that it pays him better to convert oats into hay than to grow them for grain. Oat hay is handled in all respects like crimson clover hay.

CORN.

In 1906, 3 acres of the land that had grown crimson clover was well prepared with a one-horse plow and planted to corn about June 1. The corn rows were 4 feet apart, single plants being left 15 to 18 inches apart in the row. The crop was cultivated shallow and level, so that the crimson clover sown at the last plowing could be cut for hay the following spring.

The corn was cut close to the ground about eight days after the fodder-pulling stage had passed, and it was shocked where it was and left for six weeks or two months. It was then shredded. The corn measured 66⅔ bushels per acre. The stover yielded 2 tons per acre. This is baled and finds ready sale on the local market.

Doctor Ramseur has no shredder, but employs the owner of one to come to his farm and shred his corn. It may not be out of place to state that in this section of the country owners of shredders move around from one farm to another for the purpose of shredding the farmers' corn stover. Doctor Ramseur considers good corn stover equal in food value to cotton-seed hulls.

COWPEAS.

In summer the portion of the farm not needed for corn is planted in cowpeas. The land is plowed as well as possible with a one-horse plow, then harrowed and peas sown broadcast at the rate of 1½ bushels per acre from May 1 to June 25. The seed is harrowed in. The vines are cut for hay after about one-half of the pods are ripe. At this stage they are much more easily cured into hay than if cut earlier. The vines are allowed to remain in the swath until well wilted and the leaves are dry. The hay is then raked into windrows, where it is allowed to remain until the smaller vin[illegible]n it is placed in tall, small cocks until it passes through a sweat. After it has sweated sufficiently it is carried to the field shed, where it is stacked in a large mow for about six weeks before baling. All hay treated thus passes through a heat, but not enough to cause decay.

Mixed varieties of cowpeas are never sown on this farm, for the reason that different varieties ripen at different times. The owner of this farm buys all his cowpea seed, because he thinks it pays better to sell hay than to save seed. When possible, different varieties of unmixed seed are purchased, as early, medium, and late varieties give him a better opportunity to cut the hay at the proper time.

FIELD SHED.

The field shed is cheaply constructed by erecting four posts on a square 24 feet apart; two of these are 22 feet high and two are 20 feet high. These posts are well braced, and a single pitch roof 28 feet square forms the cover. The hay is drawn to this shed after being field cured, and it remains there for six weeks, or until the manager is ready to put it into bales. It should be noted that hay sells better when baled. When this shed is filled it holds 600 bales of hay, weighing from 80 to 100 pounds each. The mow covers a ground space of 50 by 37½ feet. The hay is allowed to project 12½ feet on the front and two sides, but does not extend beyond the roof at the back, as otherwise water falling on the roof would run off on the hay.

EQUIPMENT OF THE FARM AND ITS COST.

A statement of the equipment used on the farm and its cost follows:

One one-horse Georgia plow stock, with attachments	$5.00
One one-horse smoothing harrow	10.00
One one-horse weeder	7.00
One one-horse curved-tooth slicing and smoothing harrow	10.00
One two-horse mower	35.00
One one-horse hayrake	15.00
One one-horse wagon	30.00
One one-horse hay press	90.00
One one-horse wooden roller	7.50
Total	209.50

EXPENSES AND RECEIPTS OF THE FARM.

The expenses of conducting the farm and the receipts from products sold for 1906 are as follows:

Cost of labor.

One man, twelve months, at $15	$180.00
One horse, use of, and feed	100.00

Miscellaneous expenses.

Interest on 25 acres of land, valued at $100 per acre, at 8 per cent	$200.00
Interest and depreciation on machinery, at 20 per cent	41.90
Total	521.90

Receipts.

7 acres crimson clover hay, 3,500 pounds per acre, at $1.25 per hundredweight	$306.25
18 acres oat hay, 3,000 pounds per acre, at $1.25 per hundredweight	675.00
22 acres cowpea hay, 3,000 pounds per acre, at $1.25 per hundredweight	825.00
3 acres corn, 66.66 bushels per acre, at 75 cents per bushel	150.00
3 acres corn stover, 2 tons per acre, at $15 per ton	90.00
Total income	2,046.25
Total cost	521.90
Net income	1,524.35

These figures indicate very clearly the importance of growing hay on the cotton farms of the South, where a large proportion of the hay required is brought from other States. Doctor Ramseur sold all of his hay at his barn, and could have sold more.

When it was suggested that by the use of two horses and two-horse plows, wagons, and implements, one man would be able to work twice as much land, and do especially the plowing better, the owner of this farm informed the writer that his object was to show what could be done with a one-horse farm.

Doctor Ramseur paid $15 a month for labor in 1906. For the year 1907, owing to the advance in the price of labor it was necessary to pay the same man $20 per month. This man furnishes his own house and boards himself.

APPLICATION TO OTHER FARMS OF THE SYSTEM DESCRIBED.

Comparatively few farms in the South have the supply of manure necessary to duplicate Doctor Ramseur's methods, but even where the manure from cattle is not available it would pay to grow at least enough hay for home consumption, and in many parts of the South by substituting commercial fertilizers for barnyard manure the methods described could be followed with somewhat similar results. On nearly every farm or plantation some manure is available. But even where there is no manure hay could still be grown to advantage. In some cases it would undoubtedly pay to plow under an occasional crop of rye or cowpeas to put humus into the soil; but where one is growing legumes, and especially where there is a crop of stubble to plow under every spring and every fall, there will usually be enough humus in the soil so that commercial fertilizers will make good crops of hay.

Of course it would not be possible in all parts of the South to duplicate the prices for hay received by Doctor Ramseur, but there is not a Southern State where good hay like that grown on the farm here described would not sell at a handsome profit over the cost of its production. But while very few farmers would be able to make a profit of $60 an acre on a hay farm, it would be a poor hay grower indeed, with hay at such a price as now prevails in the South, who could not make $20 an acre above expenses.

A word of caution should be inserted here concerning crimson clover. This crop has become important only in a limited section along the Middle Atlantic coast. Elsewhere results with it have been very irregular. It would therefore be wise for the prospective hay grower to experiment with crimson clover on a small scale until he is sure he has learned how to grow it and has gotten his land well inoculated for it. Practically the same remarks apply to vetch, except that the region in which vetch succeeds is considerably larger than the corresponding region for crimson clover. Vetch usually does not thrive when first sown on a piece of land, and the trouble seems to be due to the lack of the proper bacteria in the soil. By persistent effort, however—that is, by continuing to sow a little vetch on the same piece of land for two or three years in succession—the land will become inoculated, and then vetch may be readily grown; and it is doubtful if there is any hay superior to that made by vetch. A very good plan would be to sow for winter hay crops a mixture of oats, vetch, and crimson clover, or any two of these; then for summer sow cowpeas, using two or three varieties having different lengths of growing season in order to extend the period of hay harvest.

Where manure is not available commercial fertilizers should be used unless the ground is known to be rich. The fertilizers required will depend largely upon the character of the crop grown and upon the soil. In the coastal plains region there is no question that both phosphoric acid and potash should be added even to a leguminous hay crop, and for crops other than legumes some nitrogenous fertilizer should be added. One of the most successful hay growers in the South uses for cowpeas, vetch, crimson clover, and other legumes 300 pounds per acre of a fertilizer containing 10 per cent of phosphoric acid and 4 per cent of potash. This is in the coastal plains region. For crops other than legumes—such, for instance, as Johnson grass and oats—he adds about 200 pounds of cotton-seed meal. In the Piedmont region, where the soils contain more clay, the potash could probably be omitted from the fertilizer without greatly affecting the yield of hay.

There should be no difficulty anywhere in the South in getting a winter hay crop that would yield 1 ton per acre, to be followed by a summer crop of cowpeas that would yield from 1 to 2 tons per acre. Considering the price of hay in the South and the considerable income from a hay farm, the cost of the necessary equipment is not too large.

In sections where Johnson grass is well established a very good system of hay growing is to sow vetch or crimson clover, or both, with a small amount of oats as a winter crop on Johnson-grass land. Where the land is plowed early in the fall and put in good condition for the winter hay crop, two or three good crops of Johnson grass can be cut the next summer. This system will then give a crop of winter hay and two or three cuttings of Johnson-grass hay every year.

A very good modification of this system would be to grow cowpea hay every other year as the summer crop, alternating with Johnson grass, and growing a crop of winter hay each year. The system would then be, say, oats and vetch, followed by cowpeas, the land being plowed and put in good condition before sowing the cowpeas. After the cowpeas are off, disk in the winter hay crop; then the next summer, after taking off the winter hay crop, let the Johnson grass come on.

One very successful hay grower in Mississippi sows bur clover on Johnson-grass sod in the fall and pastures the bur clover during the winter, allowing it to make just enough seed in the spring to reseed the land. This treatment has increased the yield of Johnson-grass hay prodigiously. This farmer cuts Johnson grass before it heads out, or about the time it is heading, and thus avoids scattering the seed of this serious pest.

It is hoped that a description of Doctor Ramseur's work, showing the possibilities in the production of hay in the South and pointing the way to a satisfactory method, will result in more hay being grown in that section. The farmer or planter who buys hay, even at $15 a ton, when he could grow it, is wasting money. The cost of growing hay under ordinary farm conditions in the South is from $3 to $6 a ton. It is easily seen that where a farmer must pay $15 or $20—and sometimes even $25—a ton for hay, he would save a large part of his expenses by growing his own hay.

On account of the difference in the crops adapted to various soils and climatic conditions, it is manifestly impossible to lay out a cropping system for a hay farm that will suit all sections. If, however, any farmer who reads this bulletin desires to do similar work on his own farm, the Office of Farm Management Investigations, of the Bureau of Plant Industry, United States Department of Agriculture, will gladly assist in arranging a cropping system suited to local conditions.

FARMERS' BULLETINS.

Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 313.

HARVESTING AND STORING CORN.

BY

C. P. HARTLEY,

Physiologist in Charge of Corn Investigations,
Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., October 2, 1907.

Sir: I have the honor to transmit herewith a manuscript entitled "Harvesting and Storing Corn," by C. P. Hartley, Physiologist in Charge of Corn Investigations, and recommend that it be published as a Farmers' Bulletin.

The proper harvesting and storing of corn is a matter of prime importance not only to obtain the full value of the crop but also to secure the highest market price for the corn.

The illustrations which accompany this manuscript are necessary to a proper understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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HARVESTING AND STORING CORN.[a]

INTRODUCTION.

The production of a large crop is of course the subject of most importance in corn growing, but there is need of much care and labor in harvesting and storing the crop after it is produced in order to obtain its maximum value.

THE SILO.

On most well-managed farms the work of harvesting and storing the corn crop begins with the filling of the silo. Corn is one of the best crops for this purpose, if not the very best. Sorghum stands dry weather much better than corn and for dry regions is a surer crop, but it is more inclined to fall down and become tangled than corn, thus making it somewhat more difficult to place in the silo. This difficulty is overcome to a large extent by growing the two crops together, and the ensilage made from these two crops grown together is usually superior to that from either crop grown separately.

When the silo first came into use it was thought necessary to fill it with very green succulent growth. This is now known to be an erroneous idea, and the silo is regarded much as a storeroom or food preserver, the value of the ensilage depending to a very great extent on the nutritive value of the crop with which the silo is filled. To this end it is advisable that the corn shall have reached a degree of ripeness indicated by rather hard, well-dented or glazed kernels and partially dried husks before it is placed in the silo. There is a week or ten days when the ears are in this condition and the stalks still contain sufficient sap to cause the silage to pack well in the silo. It is even better to add a little water to accomplish the latter purpose than to cut the crop before it has attained its full feeding value.

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[a] The following Farmers' Bulletins in reference to Indian corn (maize), its culture, harvesting, storage, etc., will be sent without cost upon the receipt of a request therefor addressed to the Secretary of Agriculture, Washington, D. C.: No. 32, Silos and Silage; No. 81, Corn Culture in the South; No. 199, Corn Growing; No. 229, The Production of Good Seed Corn; No. 253, The Germination of Seed Corn; No. 292, Cost of Filling Silos; No. 303, Corn-Harvesting Machinery.

Many of the State agricultural experiment stations have published valuable bulletins treating of ensilage and the silo, and Farmers' Bulletins 32 and 292 of the Department of Agriculture treat especially of this subject. This publication will, therefore, deal more especially with other methods of harvesting and storing the corn crop.

CORN AS A FORAGE CROP.

Unless to be used for ensilage or cut green and fed directly to stock, it is very seldom profitable to grow corn exclusively for forage. Even when grown for the purpose of filling a silo, the feeding value of the crop is very greatly increased by the amount of grain put in the silo. If hay or forage alone is desired, independent of grain, it can usually be more satisfactorily produced by growing alfalfa, clover, cowpeas, or sorghum than by growing corn. In addition to having a higher feeding value than corn stover, alfalfa, clover, or cowpeas will enrich the soil on which they are grown. The removal year after year of crops of corn or sorghum will rapidly impoverish a soil unless an equivalent amount of humus and fertility is returned to it.

STRIPPING THE BLADES.

In some sections, especially in the Southern States, the practice of stripping the blades by hand from the standing stalks has for years been one of the established operations in connection with harvesting the corn crop. There is no question that the blades when thus gathered and well stored furnish an excellent forage, but there are cheaper methods of obtaining forage of as good or better quality.

Experiments and calculations as to cost and value have been made by the Georgia Experiment Station[a] and other stations in the Southern States, and the conclusion has been reached that the stripping of corn blades is unprofitable and should be discontinued.

TOPPING.

It is still quite a common practice in some localities to top the stalks by cutting them just above the ear. By this method the portion of the stalk which is eaten by stock most readily and with least waste is obtained. When the grain crop is late in maturing or wet fall weather prevents the proper drying of the ripening ears, the topping of the corn may be found advisable. If the ears have become hard, the kernels dented, and the husks partly dry before the topping is performed, no reduction in yield will result. A heavy growth of cowpeas may make the cutting of the entire plant impracticable and warrant the topping of the crop. If the corn is desired for seed, topping will facilitate the drying of the ears and thus make it possible to select the seed before it is injured by freezing. Ordinarily, however, it is found more expensive to top a corn crop than to cut and shock the entire plant.

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[a] Georgia Experiment Station Bulletin No. 74, p. 208. 1906.

Experiments conducted by the agricultural experiment station at Auburn, Ala., indicate that a greater profit is obtained by cutting and shocking the entire plant than by topping.

CUTTING AND SHOCKING COMPARED WITH HUSKING FROM THE STANDING STALKS.

Over large areas in the principal corn-growing States corn is grown primarily for the grain, and each farmer decides for himself how much of the crop will be cut. This is usually determined by cutting just enough to feed the animals maintained on the farm. The chief objection to this method is that many farmers do not maintain enough animals to consume all of the corn stover produced. If the ears are gathered from the standing stalks and no use is made of the stover, fully one-third of the crop is wasted. The term " fodder " is applied to the entire plants as ordinarily cut and shocked, while the term " stover " is applied to the portion remaining after the ears have been pulled or husked.

Generally speaking, there is little difference in cost between husking and cribbing corn from the shock and husking and cribbing it from the standing stalk. In some sections men will husk from standing stalks at a lower price than from shocks, but the cost of teams, although they are not usually very busy with other work during corn-husking season, must be taken into consideration. Considering the expense of husking from the standing stalk and from the shock as equal, it is evident that the stover has been obtained for the money paid for having the corn cut and shocked. This cost of cutting and shocking is very much less than the value of the stover if it be properly stored and fed. If left in the field until February or March exposed to the winds and rains of winter, it is questionable whether its feeding value is equal to the cost of cutting and shocking.

There are sections in the Central and Southern States where the soil is rich and the growing season long, causing the corn to make a large, tall growth of stalk which does not furnish a good quality of stover. In such sections it may be better to obtain the necessary quantity of forage by cutting several hay crops each year than by saving the corn stover. This is especially true in localities where warm, damp weather causes the corn stover to lose its feeding value rapidly.

TIME OF CUTTING.

In the sections where corn is grown extensively and primarily for the grain, but where it is cut and the stover fed, the time of cutting is governed by the effect which the cutting will have on the ears. When grown for grain it is not advisable to cut until the kernels have become well dented and hard and the husks partly or entirely dried. From the time the corn reaches this condition there is ordinarily a period of about ten days or two weeks in which the stover has a high feeding value and the production of grain per acre is not materially decreased by cutting. After heavy frosts, or after the leaves become brown and the stalks dry, the expense of cutting is greater than the feeding value of the stover obtained. When cut during the period above mentioned, corn stover has approximately the same value as timothy hay and can accordingly be valued at $6, $8, or $10 a ton. If cutting is delayed until the corn is mature enough to husk and crib or if small shocks of stover are left standing in the field till spring, the feeding value of the product is scarcely worth the expense of feeding it and returning the stalks to the land. There are all kinds of corn stover, and the principal factors governing the quality of any particular kind are time of cutting and care in storing.

The above statements apply to cases in which the corn is grown for grain. The cutting of corn when the ears are in the roasting-ear condition or as they are beginning to glaze makes a more palatable stover, but the full feeding value of the crop is not obtained by such early cutting.

METHODS OF CUTTING.[a]

Several methods of cutting are now generally followed: By hand; with a horse cutter drawn as a sled or on wheels between the rows; with a corn binder; and with a corn shocker. In the Northern States the corn binder is very widely used. The stalks attain a height of from 5 to 9 feet and are cut and bound very satisfactorily by means of corn binders. In the extreme north, where the stalks are but 5 feet or less, a wheat binder is sometimes used in cutting and binding the corn crop. The use of the wheat binder for this purpose, however, is not recommended, because the machine is not built for such heavy work. On the river bottoms of the Central and Southern States, where the stalks are large and attain a height of 12 or more feet, with the ears 6 feet or more from the ground, the corn binder does not meet with general favor. Doubtless binders constructed for just such crops as these would meet with greater favor than the binders designed for corn of average height.

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[a] For illustrated descriptions of various kinds of implements and machinery used in the harvesting of corn, see Farmers' Bulletin 303, entitled "Corn-Harvesting Machinery."

The method of cutting is governed not only by the height of the stalks but also by the quantity of corn to be cut. Where farms are small and the area to be cut is less than 20 acres, cutting by hand or by such a cutter as is shown in figure 1 is found more profitable than maintaining expensive machinery for the purpose. Where a large acreage is to be cut during the limited time within which it is most profitable to cut corn, corn binders or corn shockers are necessary and are the most economical means of harvesting.

HAND CUTTERS.

Although there are circumstances under which the cutting of corn by hand is advisable, there are still cut by this laborious method many acres which could more profitably be cut by corn-harvesting machinery.

Various localities have their peculiarities in regard to methods of cutting corn by hand, kinds of knives used, etc. Figure 2 shows forms of knives that give most general satisfaction. In the hand of the man shown in figure 3 is another form of knife that is very generally used. The same figure shows a shocking horse that is very convenient where the corn is cut by hand and one shock is completed before beginning another. A shocking horse is also very serviceable for shocking after a corn binder, especially when but one man is shocking. Some cutters prefer to tie down supports by twisting together, at proper intervals through the field, four adjoining hills. The tying together of these four hills forms what is known in some localities as gallowses, which support the stalks in beginning a shock. By tying down a row entirely through the field a very

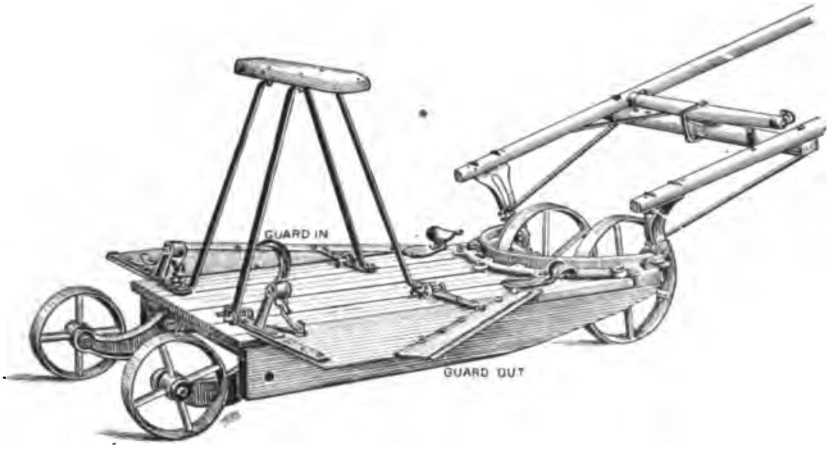

FIG. 1.—Corn harvester with automatic knife guards.

convenient system of cutting can be pursued by cutting from one shock to the next, up one side of the shock row and down the other. A very great deal of hard labor might be saved and more corn cut per day if everyone when cutting corn would adopt a definite system of procedure in cutting and building a shock.

Figure 4 explains a good method of cutting small shocks eight hills square, and can be employed by the use of the shocking horse or by tying down the four central hills as indicated in the illustration. For the first armload, hills 1, 2, 3, 4, 5, 6, 7, and 8 should be cut in the order given, and the armload stood at the point indicated by the letter *a*. The numbers and letters in the figure indicate the order in which the hills are cut and the location in which the fodder is placed. By cutting each shock after this definite system very many unnecessary steps can be saved. Other systems of equal merit can be adopted for cutting shocks of different sizes. Without a definite system of procedure much time is lost and many unnecessary steps are taken.

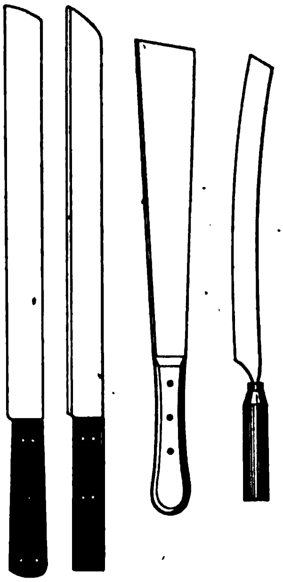

FIG. 2.—Four types of corn knives that give satisfaction.

HORSE-POWER CUTTERS.

There are many inexpensive forms of corn cutters similar to the one shown in figure 1 which by the use of a horse, or two horses hitched one in front of the other, will enable two men to cut and shock corn more rapidly and with less fatigue than by hand. In some cases the cutter is drawn on runners as a sled, but the saving in draft warrants the use of wheels. A man on each side catches the stalks as they are cut, and when the shock row is reached the horse is stopped and the fodder placed in the shock. A man with a little skill can construct such a cutter on the farm, and by means of adjustments at the points at which the wheels are attached, the knives can be elevated or lowered to cut the corn at the desired height. By the attachment of other knives lower and in the rear of the upper ones the stubs may be cut at the same operation. Inasmuch as horse power is used for cutting by this method and there are no expenses for twine or repairs and but a small outlay for machinery, it is one of the cheapest methods of cutting and shocking corn.

BINDERS.

The corn binder with bundle carrier, as shown in figure 5, is satisfactorily used in cutting corn of average or small size on land that is not very steep or stumpy. On the comparatively level prairie land of the North Central States the corn binder is very generally used in cutting and shocking corn. In light corn or on level land two horses will suffice, but for faster work or heavy corn the use of three or four horses is much more satisfactory. Three men, one to run the binder and two to shock, and two teams can cut and shock about 7 acres of corn a day. However, conditions vary to such an extent regarding the weight of the corn crop, the lay of the land, etc., that it is impossible to give figures that will apply to all cases. Under normal conditions and with an average corn crop the cost of cutting and shocking by means of the corn binder is about $1.50 per acre. In sections where the corn binder is successfully used the principal objections to its use are the cost of twine, which remains upon the fodder but a short time, and the knocking off of ears in the process of binding. In almost all cases the quantity of corn knocked off by the binder is great enough to warrant driving a wagon over the field and gathering the ears from the ground after the corn is cut and shocked. This is necessary because the presence of the shocks in the field prevents the turning in of hogs or cattle to gather up the ears knocked off by the binder.

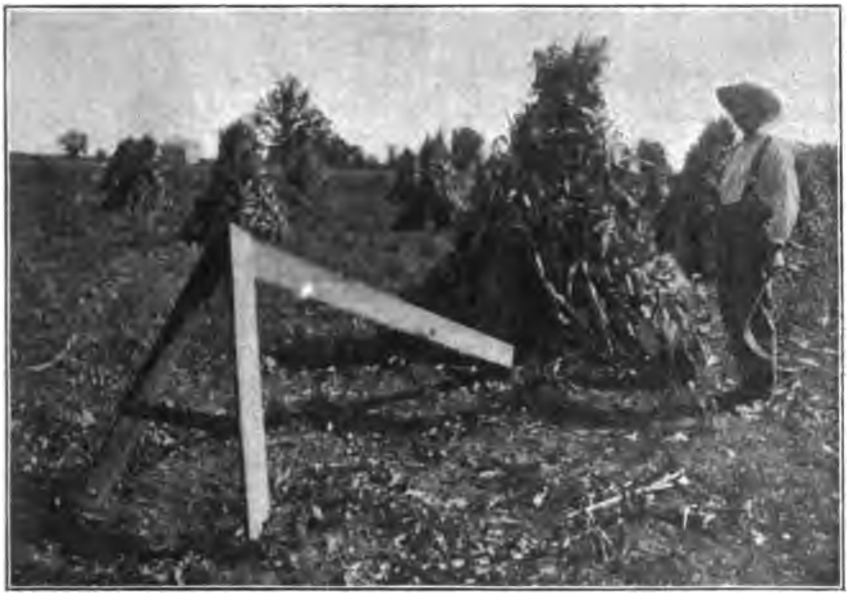
FIG. 3.—A corn-shocking horse.

The use of a binder with a bundle carrier saves very much of the hard labor of cutting and shocking, and the greater ease of handling the fodder when bound into bundles of convenient size saves labor enough to compensate for the twine used.

The stubble cutter should be attached to the corn binder whenever possible, as the early cutting of the stubs hastens their decay and puts the ground in a better condition for the following crop.

SHOCKERS.[a]

The corn shocker has not as yet met with as much favor as the corn binder, though it is now used extensively in some localities, especially in Ohio. The principal point in favor of using the corn shocker is the saving of hard manual labor. Almost all of the hard work is performed by the teams. The cost of twine is not as great as in the case of the binder, but much more difficulty is experienced in handling the fodder when the shocks are made by the shocker. The variety of movements necessary in stopping the team, unloading the shocks, and preparing the shocker for cutting the next shock are somewhat against the use of this machine by all classes of farm help. With further simplification the shocker may come into general use for harvesting corn.

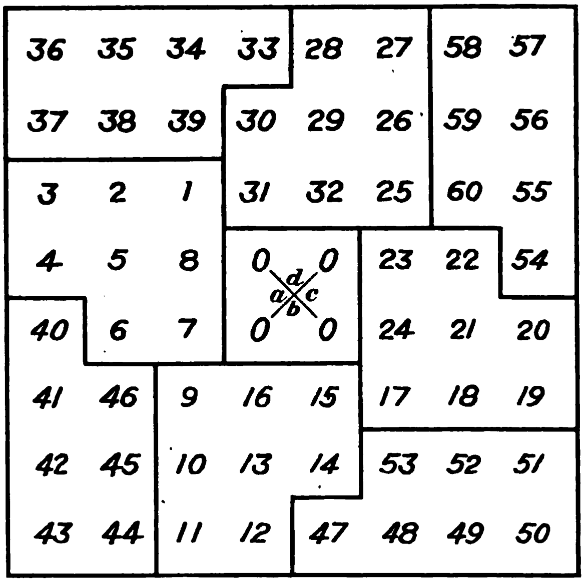

FIG. 4.—Diagram showing a method of cutting shocks eight hills square.

SHOCKING.

No matter what method is employed in cutting the corn, it is very important that the shocks be made and tied in a manner that will cause them to stand erect and keep the fodder dry. Everyone who has husked corn from the shock in the winter or hauled in shocked corn knows the annoyance and great loss due to poor shocking. It would seem as though anyone would know how to shock corn fodder, and especially anyone raised on a farm. Perhaps everyone does know how, but the large proportion of twisted and fallen shocks seen in every locality where corn is grown, especially where it is grown extensively, is conclusive evidence that many do not properly shock their fodder. To this carelessness is due the loss of millions of dollars' worth of stover, to say nothing of the grain that is also ruined.

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[a] For a description and illustration of the corn shocker, see Farmers' Bulletin 303.

BUILDING AND TYING THE SHOCK.

The stalks should be stood evenly about the shocks, with just enough slant to make them stand well against the shock. The slight slant they have should in all cases be toward the center of the shock. Too much slant is very objectionable, because in settling the slant increases and causes the shock to take water. The shocks should be tied as soon as they are made. This will prevent them from twisting or allowing the stalks to blow down before they have settled in place. Some prefer to wait until the fodder has cured a few days before tying, so that they may be tied tighter. A much better method is to tie them when first made and in about ten days tighten the ties. For tying the shocks, binder twine is the most satisfactory. A half-inch rope some 9 or 12 feet long, depending upon the size of the shocks, with a small well-curved hook made of one-half inch iron rod

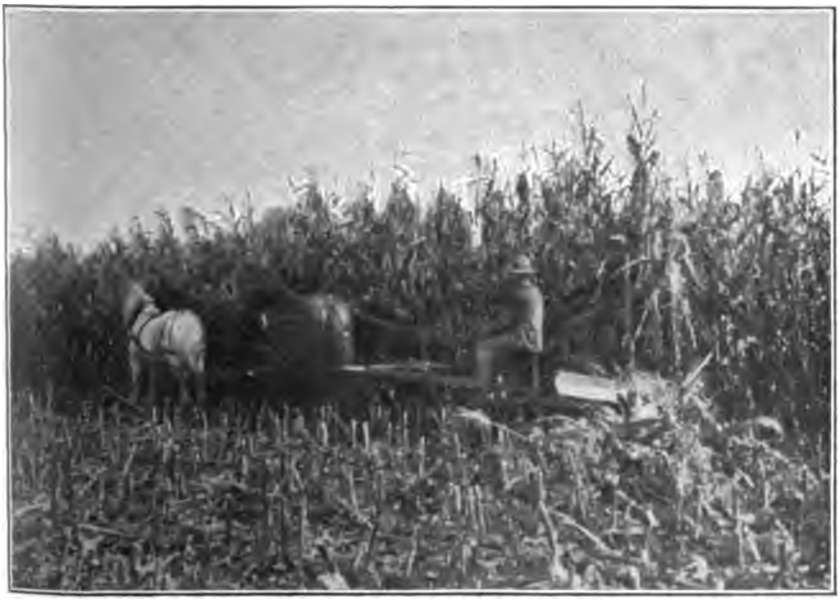

FIG. 5.—Corn binder with bundle carrier in operation.

tied in one end of the rope, is of great assistance both in tying and in tightening the ties around the shocks. The rope is placed around the shock near the top and the ring hooked over, and the rope is then drawn tightly and the loose end placed under in order to hold it securely while the binder twine is being placed in position and tied. If the corn is quite tall there is an inclination to tie the shocks too low. The tying should always be done within 2 or 3 feet of the top of the shock.

SIZE OF SHOCKS.

In dry climates and where the corn becomes well ripened about the time cool fall weather sets in, the corn shocks should be large—14, 16, or perhaps 18 hills square. Being in the right stage of maturity and with the weather dry and cool, these large shocks will not heat or spoil, and the interior, not being exposed to the rains and wind, will be preserved in a better condition than the outer portion of the shocks. In localities having wet, rainy, and warm autumns it is necessary to make smaller shocks—8 or 10 hills square. The fodder should not be left in these small shocks longer than is necessary for it to become well cured. In such small shocks nearly all of the stalks are exposed and cure quickly. The corn should then be husked out and the stover placed in larger shocks or the fodder should be hauled to the barn and placed where it will be dry. If allowed to remain in the small

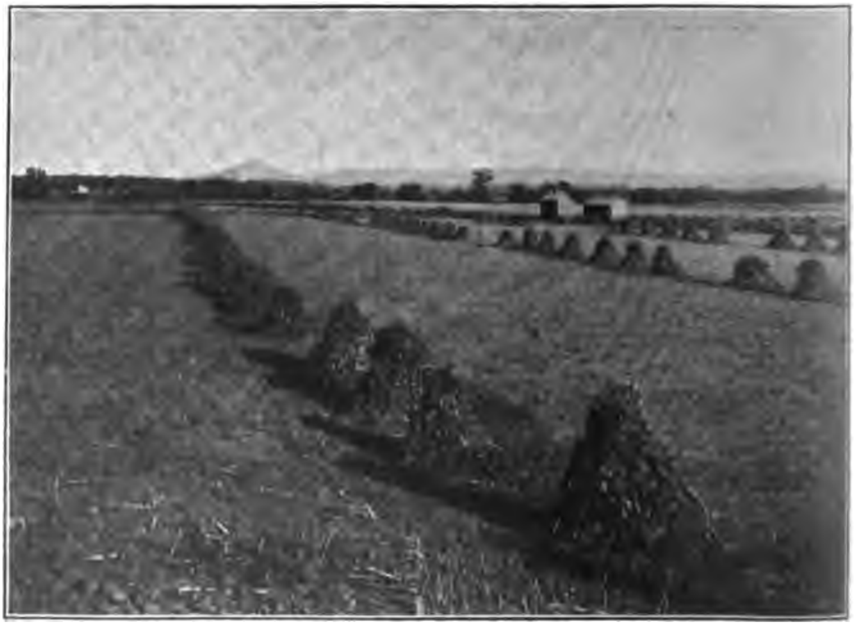

FIG. 6.—Rows of shocks placed well apart to facilitate drilling wheat.

shocks, rains will leach from the fodder the soluble and most palatable and nutritious food elements and render the stover dry, brittle, tasteless, and of little feeding value.

SPACING OF SHOCK ROWS.

It is always best to have the shock rows straight across the field, and if the corn has been checked the shock rows can be made straight in two directions. This is very essential when the ground is to be sown to fall wheat. In this case wide shock rows are advisable, and by means of the corn binder and bundle carrier this result can be easily accomplished (fig. 6).

JERKING AND STORING THE EARS UNHUSKED.

Jerking the ears and storing them unhusked is a method of harvesting employed in some sections, especially in the South, where the argument usually given in its favor is that if the husks are on the ears they are more protected from the grain weevil. The destruction of corn by this insect is one of the drawbacks to more extensive corn culture in the South, and it is hoped that tests will be made having as their object the determination of practical methods whereby large quantities of corn can be kept free from destruction by this grain weevil. As soon as the corn becomes dry enough to crib, weevils are frequently found working under the husks on the kernels of the ears, sometimes to the number of twenty or more to the ear. It is a question worthy of careful experimentation to determine whether the corn is more seriously injured by transferring the weevil with the unhusked ears to the crib than would result were the corn husked in the field, causing the weevils to drop to the ground and thereby leaving most of them in the field.

The total amount of work required to jerk the corn and afterward husk it is considerably greater than that required to husk it directly from the standing stalk, and the quantity of forage obtained by gathering the husks is not sufficient to pay for the extra work. Much better forage could be obtained more cheaply by other methods. If the husks are sold advantageously for mattress making it is well to perform the two operations of jerking the ears and afterward husking them in a manner that will furnish husks of good quality. The proportion of husk varies greatly among the different kinds of corn, but it is sufficient to say that it requires fully one-half more [illegible] to store the ears unhusked than husked.

HUSKING FROM THE SHOCK.

In sections where the farms range in area [illegible] diversified farming is f[illegible] from the shock is a common method of harvesting the ears. Figures 7 and 8 show some of the forms of husking pegs, gloves, and hooks in general use. Such gloves are too clumsy to be used except when very cold weather makes the use of gloves necessary. For keeping the ears clean and to facilitate loading the piles of corn into the wagon, sheets of ducking 6 or 7 feet square are of very great assistance and should be universally used rather than to throw the ears upon the ground, where they may become damp or even muddy and from whence it is necessary to pick them by hand. As the corn should be hauled and stored soon after it is husked, a great supply of these sheets is not necessary, for as soon as the pile of corn from one shock is loaded the sheets are ready for use at other shocks.

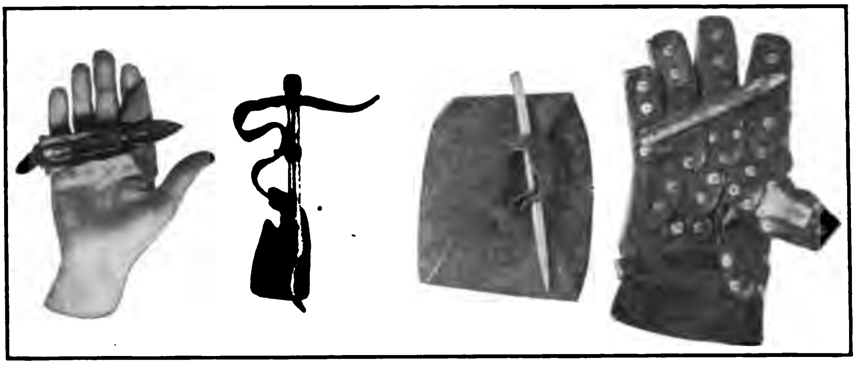
FIG. 7.—Four forms of husking pegs.

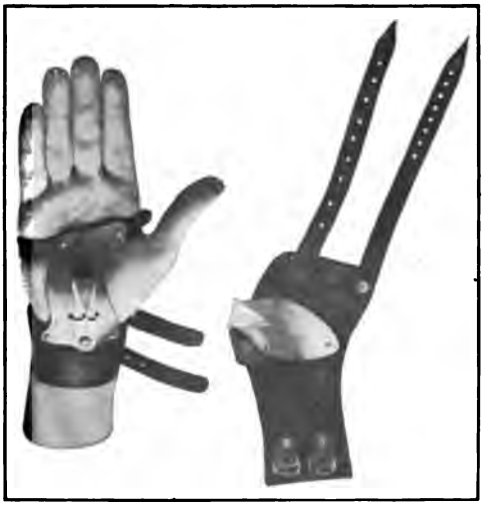
FIG. 8.—Two forms of husking hooks.

Where the shocks yield 4 or 5 bushels of corn it will be necessary to throw some of the ears into the wagon by means of a basket: the remaining ears can then be thrown into the wagon quickly by two men, each taking hold of two corners of the canvas and transferring the corn on the sheet directly into the wagon. Boxes or troughs are in some sections employed in place of sheets, but the sheets are lighter and in every way more satisfactory. During very dry and windy weather corn should not be husked from the hock, as the loss of stover is too great. Calm days when the fodder s slightly damp are ideal for husking shocked corn.

The mistake is sometimes made of husking shocked corn for animals which have plenty of time and would enjoy husking it for themselves. This is true of animals carried through the winter that need no more grain than is found on the quantity of fodder they will eat without waste. This method of feeding can not be followed with animals on full feed, as they would waste the larger quantity of stover in their endeavors to get a full feed of grain and would not obtain as much grain as fattening cattle should eat.

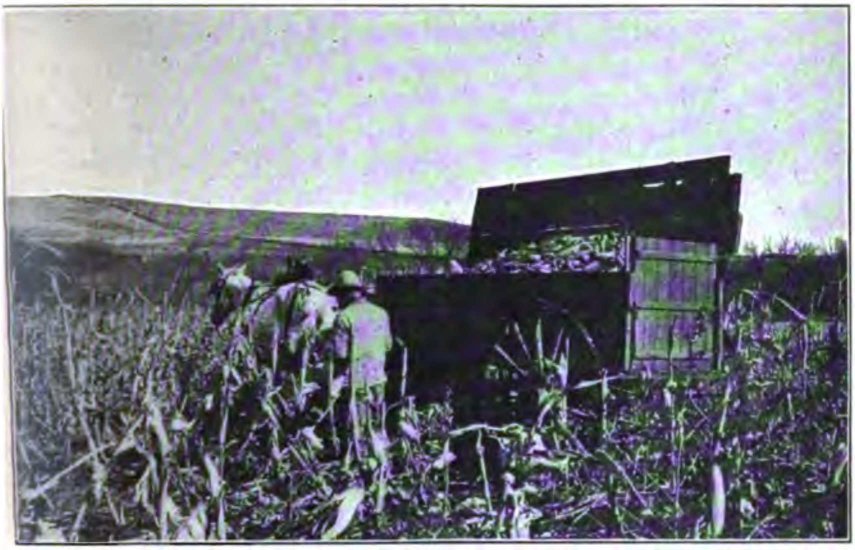

FIG. 9.—Wagon equipped with throw-board for catching the ears and with platform end gate for ease in scooping out the load.

HUSKING FROM STANDING STALKS.

Figure 9 illustrates the usual method in the Central States of gathering corn from the standing stalks when it has become dry enough to crib. As there is ordinarily not much work for the teams at this time of the year it is quite customary for each husker to have a team and wagon, or two men can accompany each wagon. In husking from the standing stalks the pegs, hooks, and gloves and peg shown in figures 7 and 8 are quite generally used, but many who prefer "hooks" for husking shocked corn find husking pegs preferable for husking standing corn. In husking from standing stalks it is customary to have on one side of the wagon a very high throw-board, against which the ears can be tossed and caused to drop into the wagon without the necessity of the husker looking up to see whether the ear has been thrown over the wagon; the noise made by the ear when it strikes against the throw-board is sufficient.

"Lands" are laid out and driven around in husking by this method so that the husker is always on the same side of the wagon and there are no down rows to husk except one for each new land started. When there are more men than teams available it is customary to have a number of men husk into the same wagon and one man haul the corn to the crib and unload. Upon his return to the field he will leave the empty wagon to be filled and take the other to the crib. With the proper number of huskers to suit the distance the corn must be hauled the work can usually be arranged so as to avoid any waiting or loss of time.

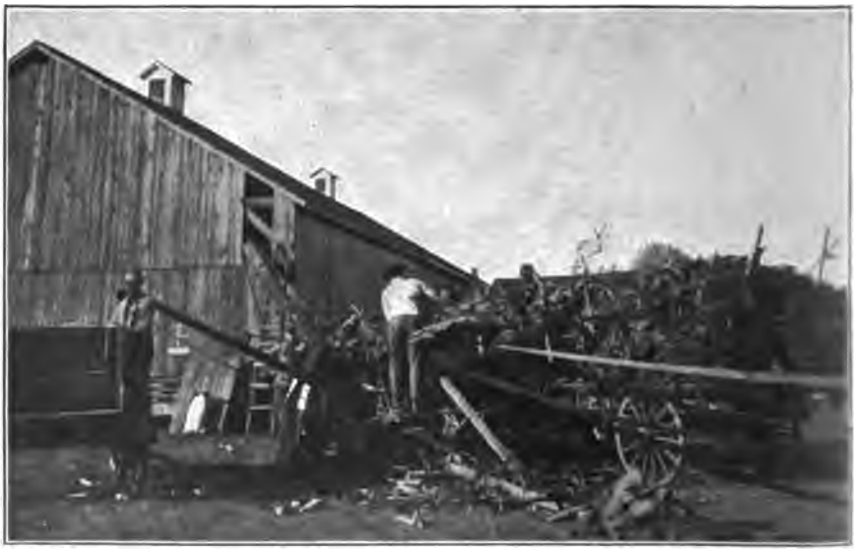

FIG. 10.—Shredder and husker in operation. The shredded stover is blown to the center of the feed shed.

HAULING TO THE CRIB.

In order to save labor and hasten the work of hauling the corn crop to the crib the wagon beds should be so deep that it will not be necessary to fill them more than level full; otherwise, ears will be lost along the road on the way to the crib. Unless the cribs are equipped with an arrangement, such as may be found at the grain elevators, for dumping the load by lowering the two hind wheels of the wagon and allowing the load to roll out, the wagon should have a rear end gate and a high shoveling board which can be lowered on reaching the crib and the scooping of the load begun at once. A wagon thus equipped is shown in figure 9. Without an end gate that will permit of the immediate use of the scoop shovel, about twice the time is required to unload.

Most successful farmers during corn-harvesting time have each load of corn that comes from the various fields passed over the wagon scales and a record made, so that at the end of the harvest the yield of each field and the quantity of grain stored will be known.

USE OF CORN-PICKING MACHINES.

At the present time much interest is being manifested in machines designed to gather the ears from the standing stalks and deliver them into a wagon driven by the side of the machine. To the man who has spent many cold disagreeable days, with sore hands, husking corn, the use of such a machine is very attractive. These machines are in their experimental stage and to their use at present there are some objections, the principal ones being that the corn is not as well husked as when husked by hand. Some ears are skipped and others are knocked off and left in the field. If the machine is equipped with a husking attachment considerable corn will be shelled in the husking and lost in the field. If the husking attachment is removed and the machine used as a corn picker, the ears can be run through a husker at the crib and the shelled corn saved. For extensive use in large fields that contain few gullies or obstacles corn pickers and huskers can be successfully employed and the crop more quickly harvested, but for the general farmer who with the aid of his regular farm help can husk by hand during the early winter what corn has not been cut for stover these machines are not profitable investments in their present state.

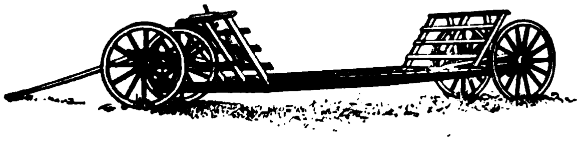

Fig. 11.—Rack for hauling corn fodder.

The proper planning of farm work so as to supply to the hired help steady employment throughout the year is the best method of maintaining sufficient competent labor upon the farm. Each farmer should so plan his work that he can employ his help by the year. It is only by so doing that competent help can be prevented from flocking to the factories and cities, where steady employment can be obtained. Corn husking can be performed at a time when other farm duties are not pressing.

USE OF HUSKERS AND SHREDDERS.

The use of shredding machines is becoming quite general in many corn-growing sections. Sometimes the machines are used for shredding the stover after the ears have been husked from the shocks by hand and in other cases both the husking and shredding are done by the machine. The shredding of the stover puts it in a more compact form for storing and a more convenient form for feeding and avoids the troublesome work of handling manure in which there are long coarse corn stalks. Shredded stover is fed with much less waste than stover in any other condition. It has been estimated that shredded stover will go 40 per cent farther in feeding cattle than the whole stalks and considerably farther than when the stalks are put through a feed cutter. As there are shredders of varying capacities, a farmer can own a machine suited to the amount of work to be performed. Shredding fodder by the acre and shredding and husking by the bushel are practices that are gaining favor in many sections, where crews operate huskers and shredders and travel from farm to farm. The blowing of the shredded stover from the shredder and husker to the center of a feed shed (fig. 10), so that shredded stover can be fed in racks around the general supply, is a very economical way of using corn stover.

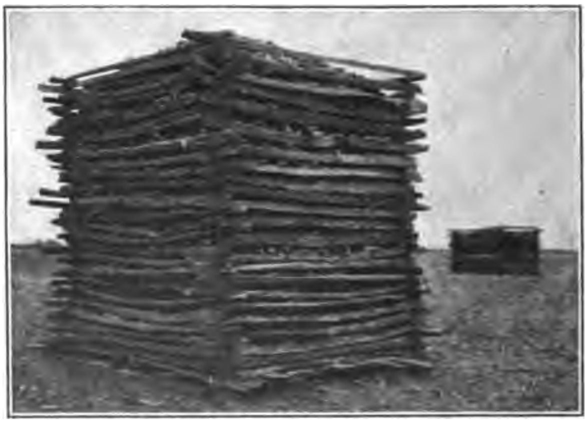

FIG. 12.—Rail pens without covers sometimes used for storing corn.

STORING THE STOVER.

Whether the stover is shredded or not, it is of great importance that it be well stored and not left long exposed to the weather. The mistake is sometimes made of placing the hay crop in sheds and barns and leaving the corn stover in shocks in the field. The reverse is better, inasmuch as most kinds of hay will not depreciate so rapidly in feeding value and will keep better in stacks and ricks than corn stover. Unless placed under cover corn stover should be fed in the fall and early winter. If left exposed until February or March it has little feeding value. There is considerable labor connected with the hauling and storing of corn stover and racks and wagons should be arranged to avoid any unnecessary labor. Figure 11 illustrates a rack that can be made on the farm and attached to the running gear of the farm wagon. In hauling the fodder or stover from 20 acres of corn this rack will save labor enough each year to pay for its cost.

In the principal corn-producing States the autumns are usually dry, and corn fodder dries thoroughly in the shocks and is shredded and stored in barns or feed sheds with little danger of heating or molding. The fodder should not be wet when shredded and stored, but damp days are preferable for doing the hauling and shredding because the blades are more pliable and the fodder is therefore handled with less waste. But in some sections, especially in northern States, where the corn is full of sap when cut and where damp fall weather prevails, much care is necessary in storing corn fodder or stover to prevent heating and molding. In such localities it should be placed under cover in ricks not more than 6 or 8 feet in thickness, or, if shredded, layers of dry straw several inches deep should alternate with layers of the shredded stover. The depth of the layers of stover can vary from several inches to a foot or more, according to its dryness when stored. The dry straw will take up some of the moisture from the stover and prevent heating.

STORING THE EARS.

There was a time in the history of the corn-producing belt when rail pens (fig. 12) were about the only available means of storing the corn crop. Much to the discredit of some corn growers this method of storing is still in vogue, even in sections where good means of storage could be afforded at little expense. It is no uncommon sight to see rail pen after rail pen filled with ears of corn and without any cover, exposed to all the rains and snows of winter, and these in sections of the country that produce the most corn and are consequently most interested in higher-priced corn. This corn remains in apparently good condition during the cold weather and is usually placed upon the market in early spring. Filled with water, it is not long after it is loaded into box cars or vessels until it heats and spoils. The installation of elevators where such corn can be kiln dried has been brought about by this poor manner of storing the corn crop. There is now a general prejudice against kiln-dried corn resulting from the fact that kiln drying was first employed and is at present employed to a very large extent to prevent further heating and fermentation of corn that was not allowed to dry properly or was poorly stored before being placed upon the market. This state of affairs, which results from allowing the corn to remain wet during winter and necessitates the removal of the water by expensive means, keeps the price of corn lower than it would be if the corn were allowed to dry in the fields and kept dry until placed upon the market. Grain buyers would pay a better price if the general supply of corn reached them in a condition that would insure its preservation without drying and the resulting shrinkage.

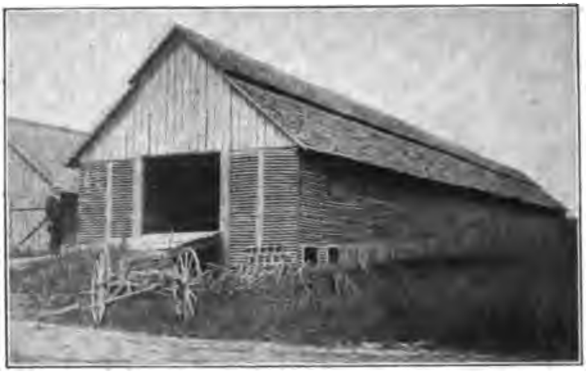
FIG. 13.—Double cribs, 240 feet long, divided into bins 6 by 8 feet to facilitate drying of the corn.

Less than 4 per cent of the corn crop of the United States is shipped from this country either as corn or as corn meal, and there is in some of the European countries a strong prejudice against American corn, due to the fact that much of it reaches these foreign countries in a condition unfit for human food. It is clearly not profitable to transport a low grade of corn such distances to be sold as poor food for stock. This state of affairs can be entirely overcome by allowing the corn to dry thoroughly in the field and then keeping it well stored until it is transported. The proper method of treating the corn crop can be quickly brought into general practice if farmers, grain buyers, boards of trade, shippers, and all who have a voice in the market price of corn insist that the price be influenced in proportion to the moisture content of the corn.

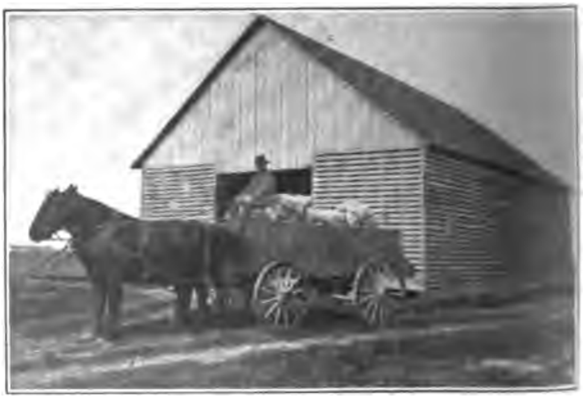
FIG. 14.—Double cribs arranged for both loading and unloading from a central driveway. The eaves should extend farther over the sides.

CONVENIENT CRIBS.

In addition to affording thorough ventilation to the stored grain and protection from driving rains, the cribs should be constructed in such a manner that they can be filled and emptied with the least possible labor. For level ground, double cribs with an elevated driveway and approaches that will enable the loads to be driven through the cribs and dumped or scooped out of the wagons without any high pitching are very satisfactory. A crib of this kind which is filled from the central driveway is shown in figure 13. The compartments of this crib are emptied from doors near the ground on the outside. The bins of which these double cribs are composed are of small size, 6 by 8 feet and 13 feet deep, thus affording the stored grain considerable ventilation. Figure 14 shows a similar crib which is both filled and emptied from the central driveway. This arrangement puts the laborers under shelter while filling the wagons in removing the crop from the crib, but it necessitates somewhat higher pitching of the corn in unloading the wagons. Figure 15 is an interior view of one side of the cribs shown in figure 14. On sloping ground equally convenient cribs can be constructed at less expense by extending the crib in such a manner that it can be filled from the upper side and emptied from the lower side. This is a very convenient arrangement, and if the slope of the hill is considerable a driveway can be made below the crib so that with properly constructed chutes the ears can be allowed to roll into the wagons, avoiding the labor of scooping. Such a sidehill crib is shown in figure 16. As the sides should be left as open as possible to permit of a good circulation of air, it is quite necessary

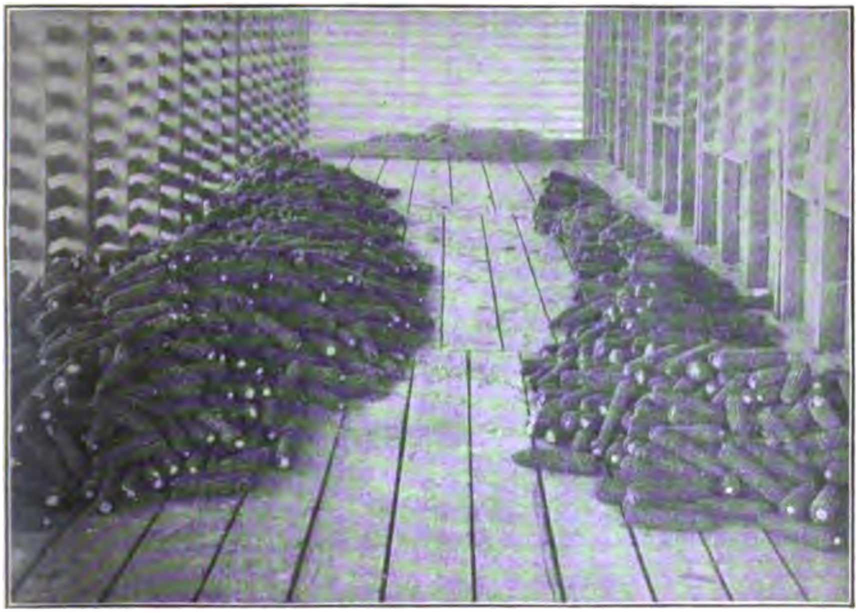

FIG. 15.—Interior view of corncribs shown in figure 14.

that the eaves extend well down over the sides of the crib so as to protect the corn from driving rains and snows.

PROTECTING THE CROP FROM INSECTS, MICE, AND RATS.

In sections where insects are destructive to stored grain, cleanliness is of value in preventing injury from this source. Small quantities of grain should not be left in the cribs during the summer, as they tend to harbor these pests. Where insects are destructive to the stored grain, it is a good practice to dispose of the entire crop as early as possible and clean the cribs thoroughly, so that there are left few hiding places and no food to carry the insects through the summer. In southern localities, where the weather is warm enough to permit these pests to work throughout the entire year, it is best to construct the cribs so that they can be made practically air-tight and then to treat the crop with some insecticide such as carbon bisulphid.[a]

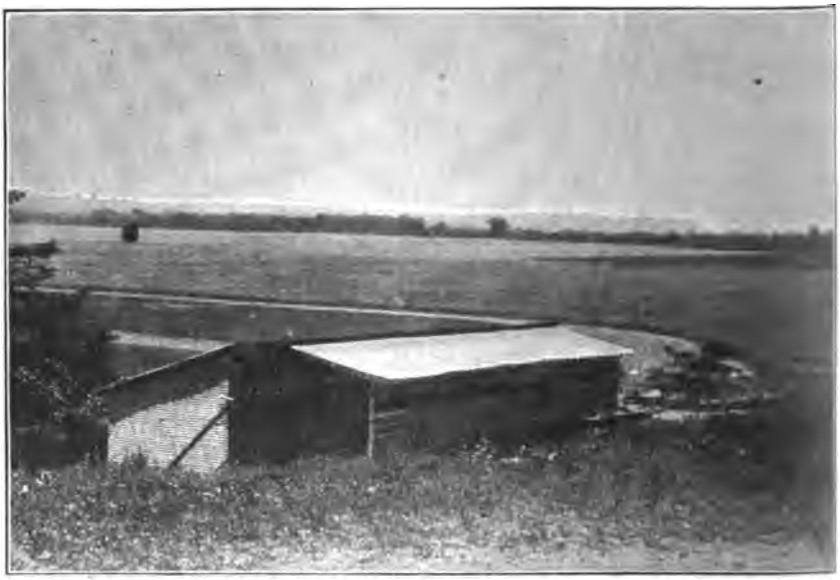

FIG. 16.—Convenient side-hill crib—easily filled from upper side and very easily emptied from lower side.

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[a] A general consideration of the principal insects injurious to stored grain is given in Farmers' Bulletin 45, Carbon Bisulphid as an Insecticide, in which remedies are also discussed. In the event of severe injury or doubt as to the nature of the insects, it is advisable to send specimens to the Bureau of Entomology for identification, which will enable the giving of advice as to the best method of control.

As a protection against rats, mice, and sparrows, galvanized wire netting of about one-fourth-inch mesh can be successfully used in the construction of corncribs. This wire netting can be tacked to the inside of the uprights of the crib, and the strips which constitute the sides of the crib can also be nailed on the inside of the uprights, thus holding the wire netting in place. As a floor, which should be 18 inches or more from the ground, so as not to afford a hiding place for rats, the wire netting can be tacked to the sleepers and the flooring nailed over to hold the wire in place. For overhead protection the wire netting is simply tacked to the joists.

If cribs are built upon solid concrete foundations through which rats can not burrow, no netting will be needed for the floor and the structure can be kept near the ground. With ample roof projection and upper ventilation no danger from dampness need be feared.

METHODS OF HARVESTING IN RELATION TO SOIL FERTILITY.

The tendency of the present times is to find use for every part of the corn plant. There are more than 40 distinct products made from various parts of this plant, and the effect of the removal of all these products from the farm is to deplete its fertility. Those who expect to continue the production of good crops of corn must keep the fertility of the land in view and have as much as possible of the corn plant consumed on the farm, selling only the completed and finished products. Stalks left standing in the field should be cut as soon as the crop is removed, so that the stalks may decay rapidly and not interfere with the following crops. Early cutting not only allows more time for decay, but early-cut stalks decay more rapidly and completely. Stalk cutters are very effective and inexpensive implements. They are made for two horses and cut one row every time they are driven across the field, or for three horses and cut two rows every time the field is crossed. Figure 17 shows one designed for cutting two rows. Wherever possible, corn should be shelled on the farm and the cobs returned to the soil.

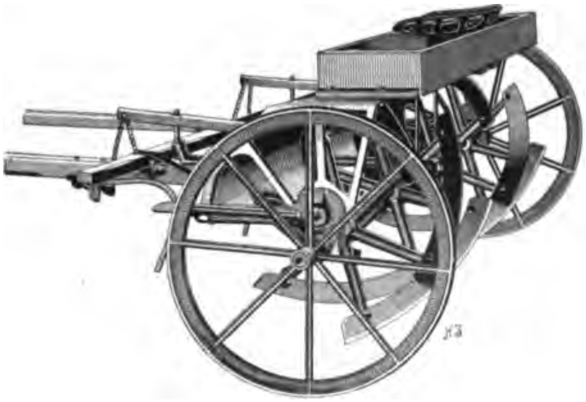

FIG. 17.—Three-horse stalk cutter which cuts two rows.

WHAT CONSTITUTES A BUSHEL OF CORN.[a]

The laws of the majority of States recognize 70 pounds of ears as a bushel of corn. Some few States specify that previous to January a bushel of ears shall weigh 72 pounds. Almost without exception the State laws specify that 56 pounds of shelled corn shall constitute a legal bushel. Unless the strain of corn has exceedingly large cobs and short kernels the legal bushel of 70 pounds of ears will yield when shelled 56 pounds of grain, or the legal bushel of shelled corn. A struck bushel of kernels of different strains of corn will vary in weight from 50 to 64 pounds.

SHRINKAGE.

The shrinkage that will take place in a crib of corn from the time it is cribbed in the fall until it is sold varies so greatly in accordance with the amount of moisture the corn contains when placed in the crib, and also the ventilation of the crib, that it is impossible to state a percentage of shrinkage that will apply with certainty to any particular crib of stored corn. Some carefully conducted tests in Illinois[b] showed that during a period of twenty-one months the shrinkage was but 9 per cent of the original weight of the corn cribbed. Other tests show that during the first year the shrinkage in cribbed corn from December to June varies from 8 to 18 per cent, with an average of 14½ per cent for the first year and an average of 20 per cent for two years.

For the ten years from 1896 to 1905 the Chicago price of corn for the month of May has averaged 3.8 cents per bushel, or 8.9 per cent, higher than the December price. As the average price in May is 3.8 cents higher than in December, a shrinkage of 8.58 per cent of the fall weight will equalize the increase in price, so that the same amount would be received whether the crop be sold in December or in May.

Estimating interest on the value of the corn at 6 per cent, a shrinkage of 5.84 per cent will make it immaterial whether the selling be done in December or in May.

In cases where 72 pounds are sold as a bushel in December and 70 pounds in May, estimating interest at 6 per cent, a shrinkage of 8.45 per cent will make it immaterial whether the selling be done in December or May.

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[a] See Bulletin No. 51, Part V, Bureau of Plant Industry, entitled "Legal and Customary Weights per Bushel of Seeds."

[b] Illinois Agricultural Experiment Station Bul. 113, The Shrinkage of Ear Corn in Cribs.

In many local points there is a much greater difference between prices in December and in May than is shown by Chicago market prices. It will, of course, be necessary for each farmer to decide for himself whether it is more profitable to sell his crop at harvest time or hold it for higher prices. Corn that has not been kept dry during the winter is usually disposed of in early spring for the reason that it is likely to spoil upon the approach of warm weather. In general it is therefore better for the farmer who has cared for his corn crop well during the winter to hold it till summer or early fall, so that the price for his crop will not be governed by that paid for wet, low-grade corn thrust upon the market in early spring.

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FARMERS' BULLETIN 314.

A METHOD OF BREEDING EARLY COTTON TO ESCAPE BOLL-WEEVIL DAMAGE.

BY

R. L. BENNETT,

Special Agent of the Bureau of Plant Industry,
Collaborating with the Texas Agricultural
Experiment Station.

WASHINGTON:
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1908.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., October 14, 1907.

Sir: I have the honor to transmit herewith a manuscript entitled "A Method of Breeding Early Cotton to Escape Boll-Weevil Damage," by Mr. R. L. Bennett, a special agent of the Bureau of Plant Industry, collaborating with the Texas Agricultural Experiment Station, and recommend that it be published as a Farmers' Bulletin.

The governing board and officials of the Texas station have given every encouragement to this work, and it is due largely to their support and cooperation that valuable results have been so quickly secured.

The method of seed selection pursued in this collaborative work and described in this paper is especially valuable to the cotton growers in the region invaded by the weevil, as it will enable them to develop by their own efforts rapid-fruiting cotton, which is most important in producing a profitable crop.

The directions for seed selection are clearly presented by Mr. Bennett and will be readily understood by growers.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—320.

A METHOD OF BREEDING EARLY COTTON TO ESCAPE BOLL-WEEVIL DAMAGE.

INTRODUCTION.

The growing of early and rapid fruiting cotton is most important to escape damage from the boll weevil. This insect, which first appeared in south Texas and rapidly spread north and east, has certain habits in relation to the cotton plant which make the production of early cotton imperative. Weevils do practically no injury to the stem or leaf, only injuring and destroying the young squares or fruit, and in normal seasons most of the adults that survive the winter are out of hibernation at about the time the cotton begins to set squares. Then a race begins between the cotton in setting squares and the weevils in multiplying and destroying the squares. The cotton plant must, therefore, make fruit faster than the weevils can increase in number and destroy it.

The weevil feeds on squares and propagates in them, but does not injure bolls of any size until the squares are nearly all destroyed. The total destruction of squares occurs late in the season, when the weevils are greatly increased in numbers. When this happens the weevils begin feeding upon the youngest or latest bolls, but at this time the older bolls, whether open or not, are safe from injury. Danger to the late bolls increases with the increase in the number of weevils present. The hasty opening of bolls is not an important factor in the crop's escape from weevil damage.

Squares generally fall from the stalk shortly after being punctured, and this removal of the young fruit from slow-fruiting and late-maturing cotton induces under favorable moisture and plant food conditions a prolonging of the vegetative growth and the setting of squares that serve as food and propagating places for an increasing number of weevils to go into hibernation when frost occurs. These habits of the weevil compel cotton growers to plant a cotton that has early and rapid fruiting qualities and the additional quality of maturing the plant as nearly as may be possible under the prevailing soil-moisture and plant-food conditions.

Until the weevil appeared, Texas growers enjoyed a long growing season and generally grew the slow and late maturing cottons. When the rapid spread of the weevil created an urgent and immediate demand for early and rapid fruiting strains, growers were unable to obtain in Texas or from any other source such cottons with other desirable qualities as well, and, moreover, there was an absence of information concerning many features of the cotton plant that affect or were supposed to affect earliness. The growers therefore sought relief from these conditions by importing from the northern and the northeastern edge of the cotton belt thousands of carloads of seed of the small-boll early-opening cotton. This imported seed being nonstormproof and of inferior staple qualities was wholly unsuited to Texas conditions.

Before any cotton-breeding investigations were begun it was generally believed that a large-boll cotton, such as the native Texas cottons, could not be grown early enough to escape the weevil. Likewise it was believed that good staple cotton could not be early. It was a question, also, whether early qualities in cottons could be maintained in Texas with its long seasons, and whether new seed would have to be frequently imported; also, whether northern seed was earlier than southern seed. Such were the conditions and some of the questions before cotton growers in Texas four years ago.

In 1904 the writer began cotton-breeding investigations and cotton breeding in Texas under the first Congressional appropriation for boll-weevil work. At the end of the first season's work, in September, 1904, a statement of results of the investigations was published for the information of growers in selecting seed for the next crop. The results were to the effect that Texas cotton growers need not import early cotton to escape weevils. The investigations showed that early cottons of superior quality could be obtained from native big-boll, good staple Texas cottons on any grower's farm by selecting seed from plants of a type that could be recognized by certain distinguishing characters, which were described in the press reports. A report was also issued in a bulletin in October, 1904. At the close of the next or second season's investigation, 1905, press reports were made and a second brief bulletin issued on the results of the second season's work.

The results of four years' investigations are now completed, and early cottons have been bred and the method for seed selection developed. The results of this work show that growers may by seed selection develop or maintain early fruiting, rapid fruiting, and productiveness in their cotton to escape weevils, and that the method of seed selection for developing such qualities in the cotton plant is easy and inexpensive in practice. One selection rightly made from the proper type of plant increases earliness and productiveness to a surprising extent. The method may be employed to the greatest advantage by growers east of Texas before the weevil arrives in that section—and that it will go farther east there is no doubt since it is making advances annually. Growers immediately east of Texas are urged, therefore, to practice the method of seed selection herein described and save themselves losses such as the Texas growers sustained when the weevil was advancing through Texas. They may also save themselves the expense of importing seed when the weevil does arrive.

In reporting the results of the work the discussion of details that are familiar to cotton growers is omitted in order to restrict the bulletin to reasonable length.

THE DISTINGUISHING CHARACTERS OF PLANTS OF EARLY AND RAPID FRUITING COTTON.

"Early cottons" and "earliness" were the terms used almost exclusively to describe plants that opened their bolls early, or that opened before frost or before other cottons. The other cottons were called "late," since they opened so late that they were in danger of frost. But a different meaning must be given to "earliness" when the boll weevil is considered. The insect shortens the season for making or maturing fruit, but this fact does not require, as has been previously explained, that the bolls should open early to escape damage. Owing to the habits of the weevil the plant must begin to set fruit early and set it rapidly, and this is the meaning of the term "early cotton" as used in this bulletin.

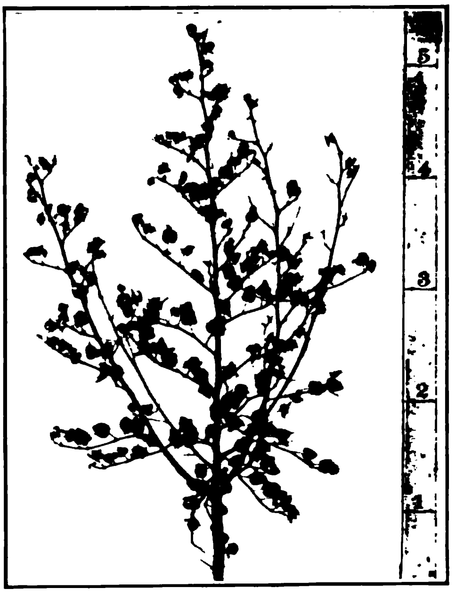

FIG. 1.—An early, rapid-fruiting, productive type of cotton plant, with low fruit limbs, short joints, and continuous-growing, long fruit limbs. (Leaves removed.)

The cotton plant is made up of a main stem, wood or primary limbs, fruit limbs, leaves, and fruit. The main stem and the wood and fruit branches are divided into joints, or nodes. At each joint a leaf is formed, and at each joint on the fruit limbs fruit is set.

In studying the many plants of all standard varieties and of nameless cottons it was observed in these investigations that the plants that set fruit early had low fruit limbs—that is, sent out the first fruit limbs at the joint nearest the seed-leaf joint. Figures 1, 2, and 3 show plants with low fruit limbs, while late fruiting plants are shown in figures 4, 5, 6, and 7.

It was also observed that the plants that set fruit rapidly (that is, set much fruit in a short period of time) had short joints or internodes in the main stem and fruit limbs. Figures 1, 2, and 3 show short-jointed plants, while figures 4, 5, 6, and 7 show long-jointed plants.

The short-jointed plants with low fruit limbs grew as fast during the first part of the growing season as the long-jointed plants, and in the same period of time set many more squares. This equal growth continued until considerable seed began to form in the lower or oldest fruits. Then as the reproductive process increased in the short-jointed or more fruitful plants their rate of growth fell behind that of the long-jointed plants. The powers of short-jointed plants are at this stage devoted more largely to the growth of seed, while the long-jointed plants are making few seeds and hence continue a more rapid vegetative growth provided soil water is sufficient, which sometimes is not the case. About this time the weevils become so numerous as to destroy the squares as fast as set on both types of plants, and the short-jointed plant matures its larger crop of squares that are already set, whereas the long-jointed plants, having set but few squares, mature but little fruit, although they may continue to grow.

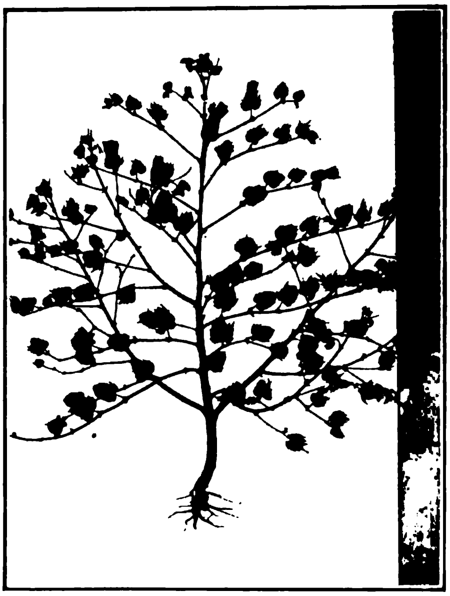

FIG. 2.—Another early, rapid-fruiting, productive type of cotton plant, having characters similar to those shown in figure 1. (Leaves removed.)

Previous to the weevil's shortening of the fruiting season the long-jointed plants made in the long season a good yield, since they had time to increase the number of joints and the fruit by growing to a large size, but with the weevil these late plants fruit rapidly at the wrong end of the season. Rapid fruiting must begin at the first part of the growing season at the base of the plant and not at the latter part of the season at the top of the plant.

The rate of growth is very important for the rapid setting of fruit, and as some individual plants of either the long-jointed or short-jointed types grow faster than other plants of the respective types it is important to select seed from the largest plants of the character or type desired.

Another important character of early rapid-fruiting plants was found, namely, the continuous growing of the fruit limbs. This feature is of great importance for a maximum production in a short time. The terminal bud of the first fruit limb and of all subsequent fruit limbs should continue to grow and set squares, or fruit, until the entire plant ceases to grow. With fruit limbs of such a character the main stem may not grow so tall, but the continuous-growing fruit limbs make more fruit early in the lower part of the plant than either a determinate or cluster fruit-limb type. (Fig. 8.) Where there are weevils, continuous-growing fruit limbs are a great advantage in making a large quantity of early fruit. The quality has still another advantage as regards this insect, namely, the weevil seems instinctively to feed on the squares higher up the plant and thereby very often allows late-set squares to make bolls on the lowest continuous-growing fruit limbs. The continuous-growing fruit-limb type is shown in figures 1, 2, and 3. The short or determinate (or objectionable) fruit-limb type is shown in figure 9. The latter type may set and mature two or four bolls on the lowest or first fruit limbs, whereas the continuous fruit limbs may mature from six to eight or more.

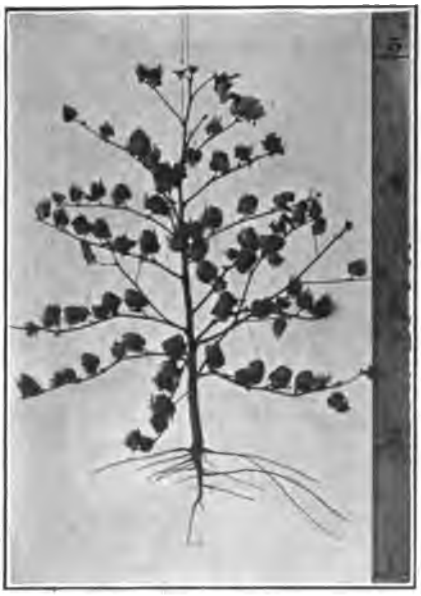

FIG. 3.—A third early, rapid-fruiting, productive type of cotton plant, having characters similar to those shown in figures 1 and 2. (Leaves removed.)

The low first fruit limbs and short joints and the continuous fruit limbs which were first described by the writer in the press in September, 1904, and later, in October, 1904, in a bulletin, as a guide in seed selection, are distinguishing characters of early rapid-fruiting cotton plants. By these characters the grower can distinguish early and rapid-fruiting plants, and in selecting plants for seed he may select them at any time after fruiting has well begun or may delay selection until all bolls are open.

A medium-sized leaf, about 6 inches across at right angles to the midrib, is as large as a leaf should be for upland soil. Larger leaves mean too great vegetative vigor, and they prevent in large plants the sunlight from reaching the lowest bolls and opening them. A still smaller leaf, 4 to 5 inches across the midrib, is shown in figure 10. This is a desirable size for deep, fertile bottom soil, where still less vegetative growth and the admission of more sunlight at the base of the plant are desirable. An undesirable large leaf is shown in figure 11.

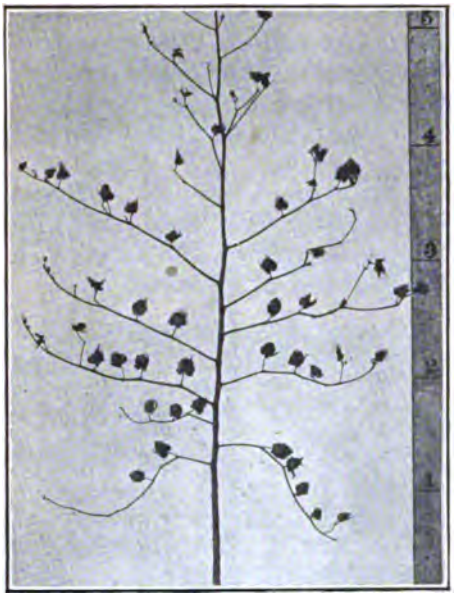

Fig. 4.—A late, slow-fruiting, unproductive type of cotton plant, with high fruit limbs and long joints. (Leaves removed.)

THE INDIVIDUAL COTTON PLANT AND ITS PROGENY.

The cotton plant in seed selection was studied with respect to its features as an individual and not considered as a variety. Its economic features are seed and lint, and the production of these in the greatest quantity is the desire of the grower. Other features that affect the economic characters are the size of the boll, the size of the leaf, the structure of the stalk as regards the length of the joint, the fruit limbs, and the wood limbs. All of these features vary in degree in the progeny of different plants, but each plant, as shown in these investigations, transmits its features to its progeny with certainty and uniformity, except the variation in certain individual plants due to natural causes and to crossing by insects. This

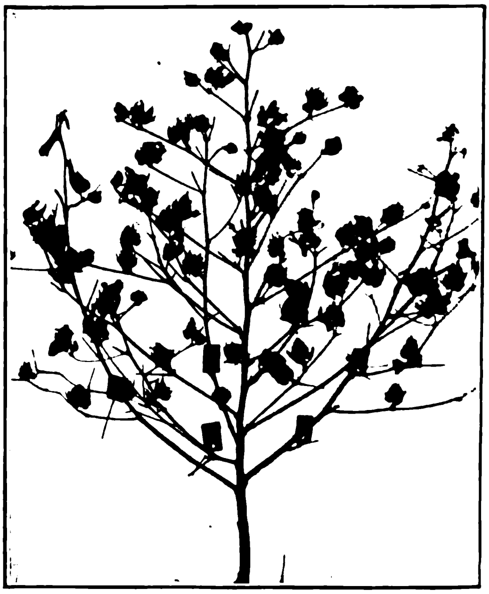

Fig. 5.—Another late, slow-fruiting, unproductive type of cotton plant, with characters similar to those shown in figure 4. (Leaves removed.)

uniformity is a most fortunate fact, since it enables growers to obtain in a marked degree by one seed selection the qualities of early and rapid fruiting and maturity of plants necessary for escaping boll weevils. Any crossing that may vary the progeny is perhaps caused entirely by insects and is of little or no consequence within the type in general farm selection.

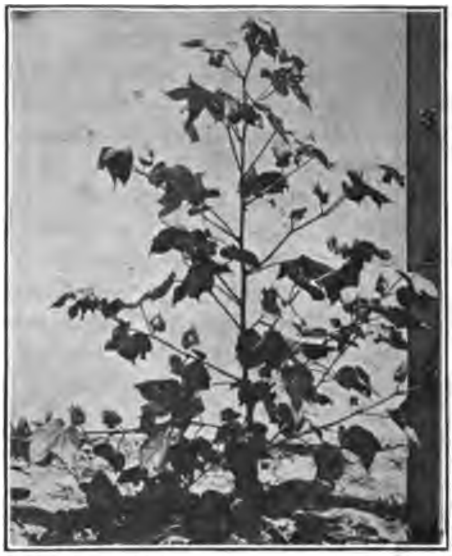

FIG. 6.—A third late, slow-fruiting, unproductive type of cotton plant, with characters similar to those shown in figures 4 and 5.

In this work some hundreds of plants were selected and the seed of each mother plant was planted separately in a single row of one-fiftieth of an acre, with equal spacing and similar treatment for all rows. The plants in each row were uniform in appearance. The variation in the rows may be seen in figure 12, which shows rows differing distinctly in the time of maturing. In like manner the rows differed in the time of opening their ripened bolls and in the yield of seed cotton, as is shown by the one-half acre of rows reported upon in Table I, page 12. The planting was done between April 10 and 13, and the first picking took place on September 7, 1906.

When the seeds were planted from these first-year progeny rows they made plants of the second year like their parents, thus showing that the plants continue to breed true to their type.

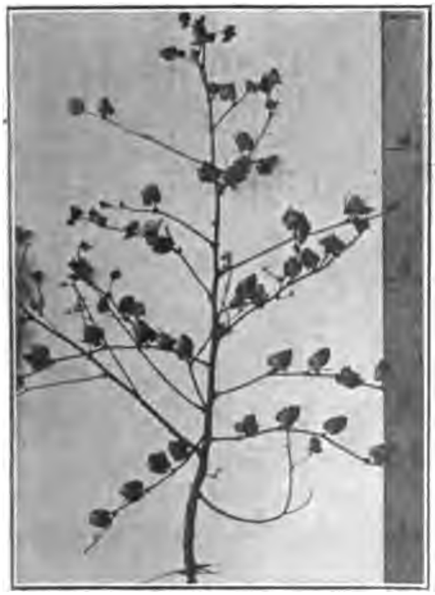

FIG. 7.—A fourth late, slow-fruiting, unproductive type of cotton plant, with characters similar to those shown in figures 4, 5, and 6. (Leaves removed.)

The character of productiveness of fruit in the parent plant appeared uniformly in the second-year progeny. The seed of plants selected for short joints and early maturity of the plants produced like characters in the second-year progeny. The progeny of plants of long-jointed, slow-fruiting, unproductive types was also uniform in likeness to the parents, as is shown in figure 13. The plant illustrated is two generations from an unproductive mother plant and grew in a row near and is of the same age as the plant shown in figure 2, which is a short-jointed productive type. The latter is the second generation from a short-jointed parent. Hitherto it has been generally believed that soil water controlled the length of joint, but these results show that heredity mainly controls, and that where water affects the length it affects similarly the long-jointed and the short-jointed types of plants. The first and second progeny resembled the seed parent, whether short jointed or long jointed. Low fruit limbs at joints nearest in number of joints to the seed-leaf joint, a very important quality, appear uniformly in the progeny.

TABLE I.—*Yield of progeny rows of cotton plants in selection tests covering one-fiftieth of an acre each.*

Number of row.	Average height.	Yield at first picking.	Yield at second picking.	Total yield.
	Feet.	*Pounds.*	*Pounds.*	*Pounds.*
39	2½	27⅝	6	33⅝
4	3	31	4	35
37	3	28	4½	32½
8	3¼	34	5	39
10	2¾	32	4	36
21	3½	33	6	39
32	3½	32	8	40
67	3¾	25	11	36
65	2½	30	3	33
100	3¾	26	10	36
124	3	31	8	39
131	3½	26	14	40
88	4½	24	14	38
98	4	26	15	41
129	2½	28	3½	31½
52	3	27	7	34
55	2½	24	½	24½
47	3½	33	12	45
24	3½	31	5	36
118	4	29	12	41
135	3½	30	9	39
103	3½	37	7	44
127	3¾	28	9	37
8 L	3½	22	15	37
17 L	3½	27	13	40
Yield on the half acre				927
Yield to the acre				1,854

The continuous growth of the fruit limbs, also an important quality, is uniformly present in the product of such a mother or seed plant. This uniformity of transmission is likewise constant as regards such qualities as the length of staple, size of boll, number of locks, and percentage of lint. Each of these features costs nothing in itself, yet adds profit to the crop.

The number of locks in a boll, however, does not always appear to be the same as in the parent plants. The variation from five-lock bolls in the parents to four-lock bolls in some cases in the progeny plants may be due to seasonal influences, since the progeny seed may the following season produce almost exclusively five-lock bolls. The same seasonal variation occurs in the percentage of lint to seed. These seasonal variations, however, do not affect the general increase by seed selection of five-lock bolls, the percentage of lint, or the transmission of such qualities to the progeny.

The uniformity of progeny in resemblance to the parent has been the favoring factor in the introduction of the large number of varieties of American Upland cotton, many of which have no merit or excuse for having been produced, the feature distinguishing them from other varieties being often some unimportant detail in appearance of leaf or in a determinate or cluster character of fruit limb.

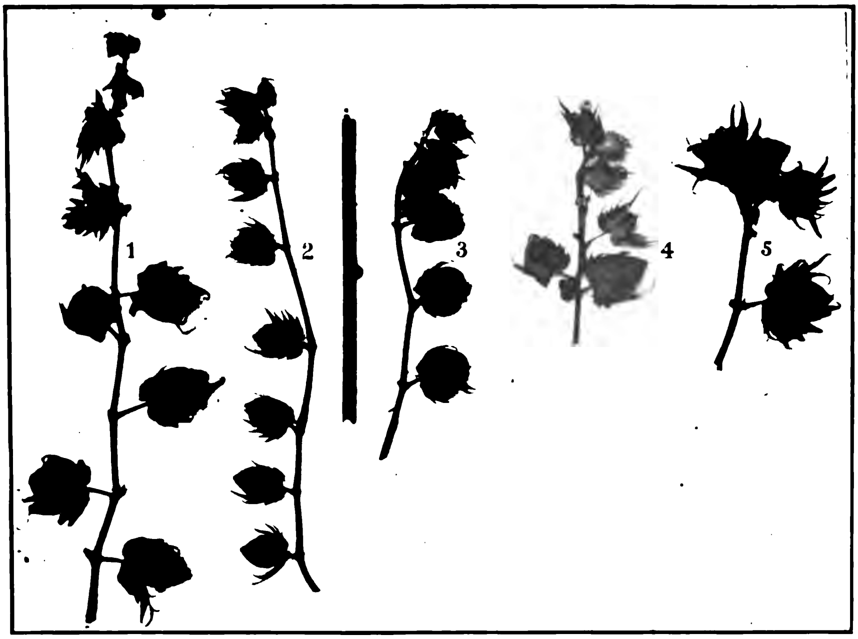

FIG. 8.—Big-boll (1) and small-boll (2) continuous-growing fruit limbs and short determinate (3 and 4) and cluster (5) types of fruit limbs.

The uniform transmission of characters is of the greatest importance to the general cotton grower, because it assures him that by one seed selection he can largely increase the desirable qualities of his cotton.

THE TYPE RECOMMENDED FOR EARLY, RAPID FRUITING, AND FOR PRODUCTIVENESS TO ESCAPE WEEVILS.

The type wanted must be clear in the mind of the grower in order that he may recognize the most perfect plants of the desired type when searching for them in his field or seed patch. From the description previously given of the distinguishing characteristics of an early, rapid-fruiting, productive cotton, it is easy to state the type in specific terms.

(1) The first fruit limb must be low, not higher than the fifth or sixth joint above the seed-leaf joint.

(2) The wood or primary limbs must be low, and it is desirable that they should not exceed four in number. The first limb should not be higher than the fifth or sixth joint above the seed-leaf joint.

(3) The joints in the main stem, in the fruit limbs, and in the primary limbs must be short, not exceeding 1 to 3 inches in the lower part of the plant.

(4) Fruit limbs should grow at the successive joints of both the main stem and the wood limbs.

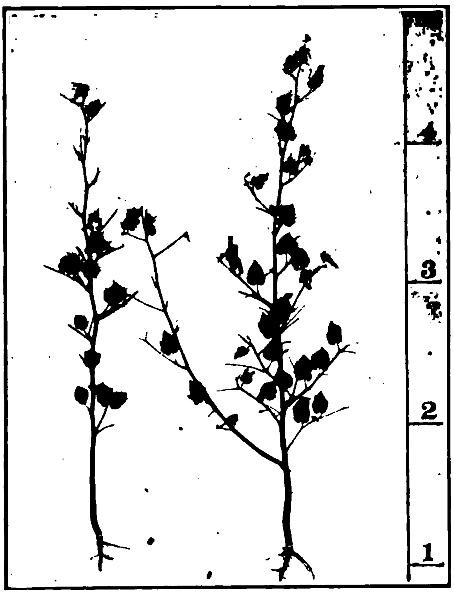

FIG. 9.—A short, determinate fruit limb type of cotton plant. (Leaves removed.)

(5) Fruit limbs should be continuous in growth for continuous fruiting until the plant is matured.

(6) The largest leaves should not be wider than 5 or 6 inches across at right angles to the midrib.

Other qualities which do not affect early and rapid fruiting, but which add greatly to the profits of the crop, are size of boll, percentage of lint, length of fiber, and storm resistance.

Picking can be done more rapidly and less trash will be gathered with the cotton when the boll is large. Large bolls are also storm resisting, since the boll covering is thick and does not curve backward in drying and leave the locks unsupported (figs. 14 and 15).

A cotton should yield as large a percentage of lint as possible. About 38 per cent is the general yield of the few varieties that give the highest percentage. The proportion of lint, however, seems to vary more or less with the season. By selecting for lint, as much as 40 per cent may be made to grow regularly and on a seed of good size and in a large boll.

The fiber should not be less than an inch long, and this length is sufficient for general purposes. For special purposes of finer manufacture longer fiber is required, but the quantity called for is relatively small as compared with the total requirement for 1-inch staple. Fiber much shorter than 1 inch can be and is used; but were there much of such short staple its value relative to that of 1-inch staple would be less than is ordinarily the case.

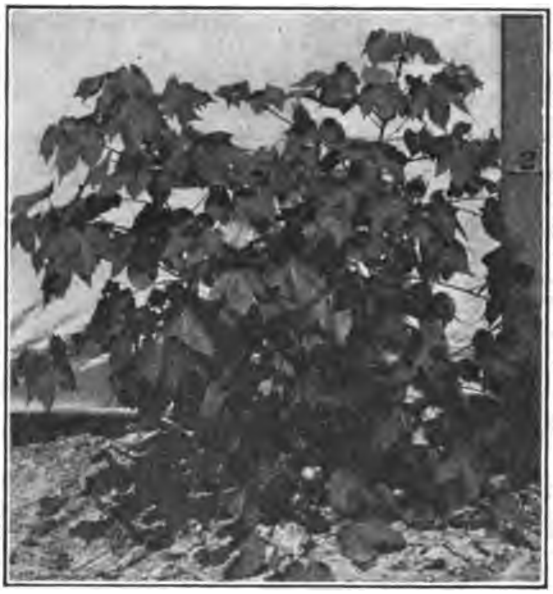

FIG. 10.—A small-leaf type of cotton plant.

The leaf has no market value, but if too large—more than 6 inches across at right angles to the midrib in the largest leaves—it prevents the drying of the lower bolls and, where the plant is large, causes the loss of bolls by rotting.

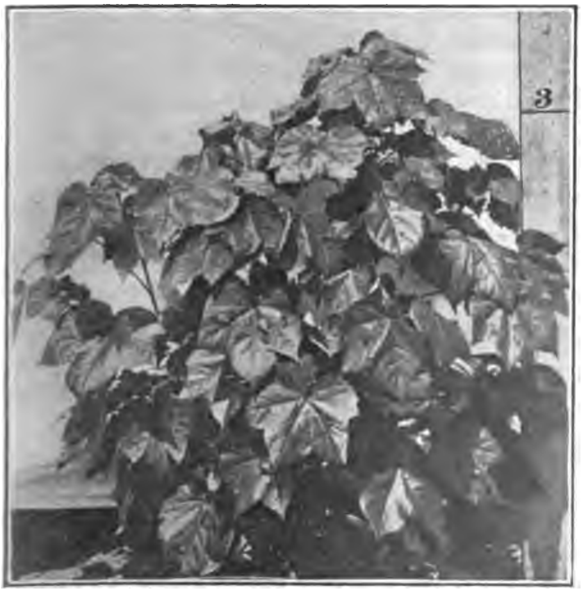

FIG. 11.—A very large leaf type of cotton plant.

The type of which the foregoing is a description is shown in figures 1, 2, and 3.

As before explained and as may be seen in Table I, the opening of the bolls of one plant earlier than those of another does not indicate superiority in escaping weevils. The weevil stops all plants from fruiting at the same time, and the cotton which yi[illegible] the most is the one that best escapes the weevil, regardless of the date of opening. Large-boll cottons rarely begin to open as early as some small-boll cottons, though both begin setting fruit at the same time. But notwithstanding the few days' delay which may occur in the opening of the large bolls, some large-boll progeny rows in our experiments yielded more cotton than the small-boll early-opening progeny rows. (Compare rows 8 L and 17 L with rows numbered 129 and 55 in Table I.) This point as to the opening of bolls is specially emphasized and explained because a large boll is more desirable for many reasons than a small-boll cotton and is preferred by growers and pickers. The belief was quite general when this work began that the opening of bolls even a few days earlier than those of other varieties was of importance in escaping weevils, and as the earliest opening cottons at that time had small bolls and the old late cotton had large bolls, the conclusion was reached that a lorge-boll cotton could not be grown

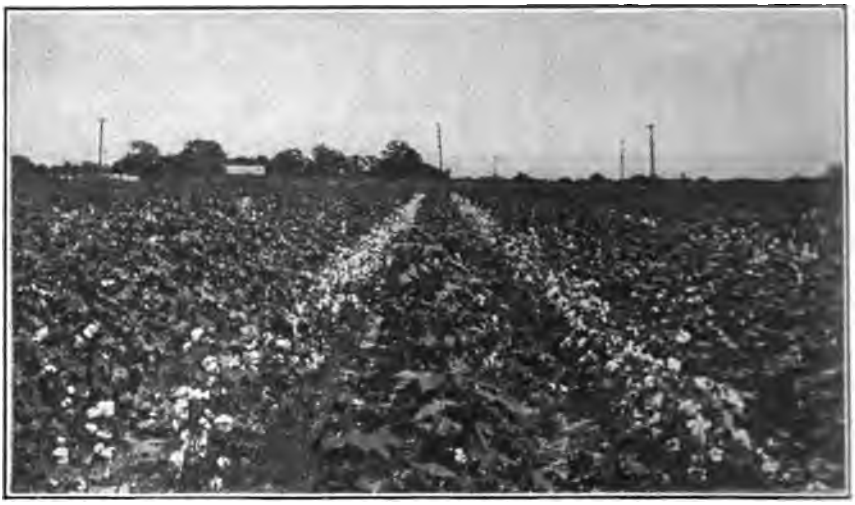

FIG. 12.—Progeny rows showing defoliate and foliate rows of early rapid-fruiting types of cotton.

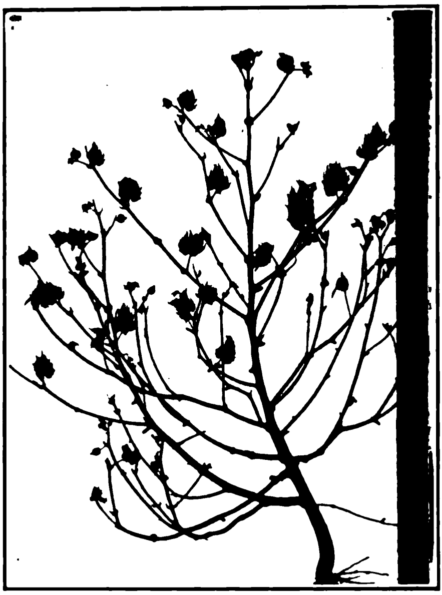

FIG. 13.—Cotton plant bred for unproductiveness and late fruiting. (Leaves removed.)

to yield successfully where there were weevils. Moreover, it was thought that the simultaneous setting of squares on different cottons should be followed by the simultaneous opening of their bolls. A similar belief equally erroneous would be that cottons setting squares at the same time should have bolls of the same size, shape, etc. The most successful escape from weevils is indicated by yield and not by the date of the first open boll or by greater yield at the first picking, and large-boll cottons have been bred in this work to fruit early and rapidly and to escape weevil damage as successfully as any small-boll cotton that opens all its bolls ten days or two weeks earlier.

SEED SELECTION FOR EARLY, RAPID FRUITING, AND FOR PRODUCTIVENESS TO ESCAPE WEEVILS.

Seed selection is generally believed to be a long process, one where a little progress toward improvement is made each year and in the course of several years the desired result may be obtained. This breeding work with cotton has shown that in the first selection from the right type of plants a marked increase can be secured in early fruiting, rapid fruiting, and productiveness, combined with good-sized bolls, a good average percentage of lint, and a good length of staple. If growers wish to develop such qualities or to maintain them in a cotton they can do so by pursuing the method of seed selection here recommended. They can by one year's selection largely increase the early, rapid-fruiting qualities in a cotton and obtain a crop that will successfully escape serious weevil damage.

For the best results a grower should make his selections from a cotton that conforms nearest to the type for boll-weevil conditions. There are many varieties that are far from this type, and to begin selection from them would be a decided disadvantage. Texas growers prefer a large-boll cotton, 50 to 60 boils to a pound. The bolls of many varieties are so small that it takes 90 of them to yield a pound of cotton (fig. 16) and picking is necessarily slow.

There is a disposition on the part of many growers to judge the yielding quality by the eye when all the bolls are open. This practice is extremely deceptive with a small-boll small-leaf cotton as compared with a large-boll medium-leaf cotton. The latter shows less bolls than it really has because of its larger leaf, and it may have fewer bolls but exceed the yield of the smaller boll cotton. Only with scales can a considerable difference in yield be determined.

After all bolls are open, the stalks of the type are selected and all the largest bolls around the center of the stalk should be picked for seed. All bolls at the top and ends of the limb, whether open or not, may be rejected—perhaps about one-third of all the bolls—only about two-thirds being picked. Around the center of the plant the most perfectly matured and largest bolls are grown, and their seeds are heavy, well developed, and well matured. In rejecting the smaller and defective bolls all weak and light seeds are excluded. Where growers plant seed from the first picking of all bolls without any selection as to either plants or bolls, they get seed from all kinds of stalks and bolls, and get heavy and light seed, making an average grade of seed and an average yield.

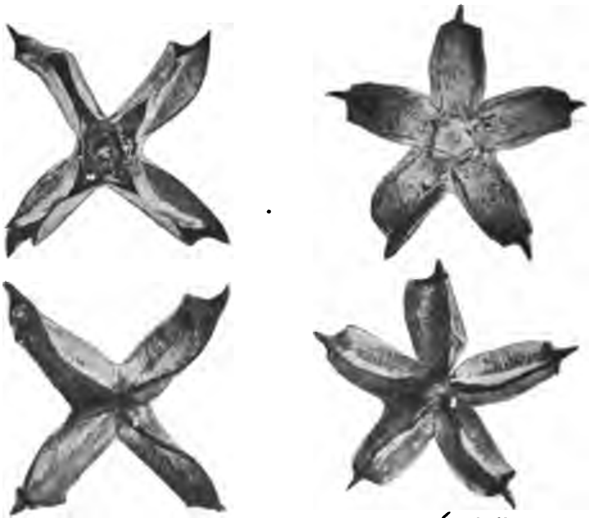

Fig. 14.—Small non-stormproof, open cotton bolls.

Growers generally consider seed selection a heavy task, and it would be so if enough seed were carefully selected to plant a grower's entire crop, but selection on a large scale is unnecessary. A grower cultivating 50 acres of cotton and planting 1 bushel of seed to the acre, which is the quantity generally used, would require 50 bushels of seed. This quantity of seed should be grown on a seed patch, which should be made to produce as much as three-fourths of a bale to the acre, by using either good soil or fertilizer. Thus 1,200 pounds of seed cotton would yield 800 pounds of

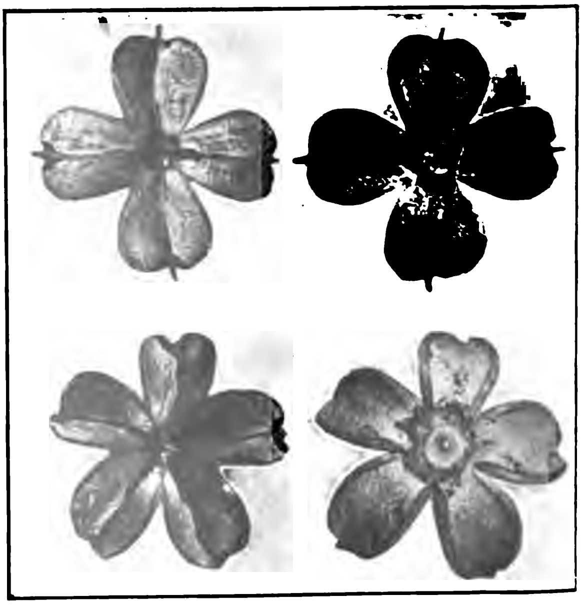

Fig. 15.—Large, thick, stormproof, open cotton bolls.

seed, and by picking only two-thirds of the crop for seed the yield would be 533 pounds, or 18 bushels of planting seed to the acre.

A seed patch of only 3 acres would make 54 bushels, or 4 bushels more than enough to plant a grower's 50 acres of general crop. To search carefully for enough type plants to plant the 3-acre seed patch is a small task. One peck of seed to the acre is enough, and 24 pounds, or 3 pecks of seed, represent 36 pounds of seed cotton to be picked from type plants. Should the type plants yield one-fifth or one-fourth pound each, it would mean finding and picking 180 or 144 type plants. The first year's selection of the 200 type plants could be made from the general crop, and selections after the first year would be from the 3-acre seed patch. After selecting and picking enough type plants to plant the seed patch, two-thirds of the remainder is picked to plant the general crop. Should a grower cultivate 100 acres a 6-acre seed patch would be needed.

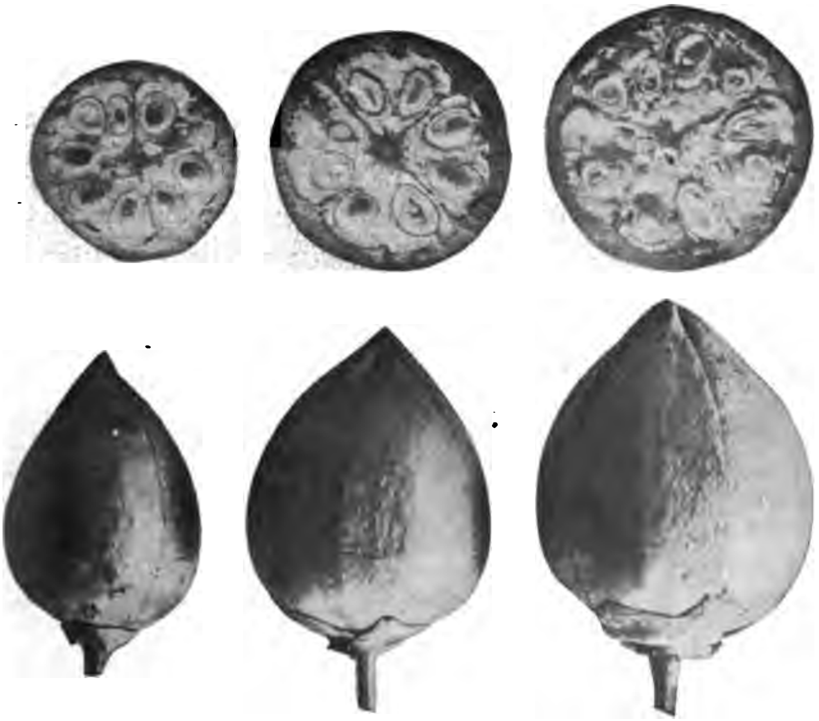

FIG. 16.—Cotton bolls showing distinct differences in size. Large boll on right, 40 to the pound; medium boll in center; small boll on left, 90 to the pound.

In general seed selection the plants may be selected and picked together and not kept and planted separately, but where the grower is disposed to give the necessary time and care to the matter the seed of each of the 200 or 300 type plants may be planted in separate rows to determine through the progeny the individual plant that has the greatest producing power. In this case the seed patch is not planted until the second year, and it is then planted with the seed of the row that produced the most cotton. The producing power of the mother plants varies, as shown in the yield of progeny rows in Table I, but growers will get increased earliness and productiveness by one selection of seed plants without growing them separately. Owing to the details and care involved in determining the producing power of individual plants and in breeding for longer staple, finer quality, and high percentage of lint, on the other hand, such work is specialized and is more within the province of the breeder than of the general grower.

The usual description of planting seed offered for sale is the seller's assertion that the cotton made three bales or more per acre and that it is the best cotton on earth. Usually the seller's qualifications for judging cotton and his financial standing are unknown to the buyer. Many cotton growers have become skeptical of so-called improved seed, doubtless because of purchases from such sources. Where the grower finds it convenient to buy seed to plant his seed patch he should require the seller to state the qualities of the cotton in the terms of the type.

The size or diameter of boll in type or parent plants is easily measured by a caliper rule. A very sharp pointed boll is objectionable in picking, and a very round boll contains less cotton than an elongated boll of the same diameter. The height of the first fruit limb above the seed leaf joint and the fact that the fruit limbs are continuous in growth should be determined; also the length of joints of the fruit limbs and main stem and all other features specified in the type for early, rapid fruiting and productiveness.

Most of the long-staple varieties of Upland cotton have been developed for length of staple, and little attention has been given to early and rapid fruiting or to increasing the percentage of lint, but each of these qualities may be increased in long-staple cottons by seed selection from individual plants that have these qualities most highly developed.

Deterioration of the qualities in cotton comes about through nonselection of seed. Where seed selection is not pursued, the planting seed comes from both good and poor stalks, from immature, diseased, and insect-injured bolls, and from plants resulting from the crossing of good and poor varieties by insects.

If seed selection is not persisted in, high-grade seed will quickly deteriorate in productiveness and in other qualities. Failure to select seed accounts for the common complaint among growers that even seed that is very productive for the first few seasons soon declines.

EARLY AND RAPID FRUITING MEASURED BY THE YIELD OF THE SELECTIONS IN THE BOLL-WEEVIL DISTRICT.

After the type for early and rapid fruiting was determined in 1904, many individual plants conforming to this type were selected from a common Texas cotton, the name and history of which could not be learned. Its earliness and productiveness were above the average. Dr. J. H. Wilson, of Quanah, Tex., secured the seed in compliance with the request of the writer for a supply of seed of common Texas cotton. The results with a half acre of progeny rows planted with seed of parent plants are reported in Table I. The average yield to the acre of the progeny rows was 1,854 pounds, while the yield of Quanah common seed was 1,630 pounds. The gain in yield per acre was therefore 224 pounds.

The seed of the best yielding progeny rows was planted in 1907, and the plants were true to the type and characters of the parent progeny rows and to the original parent plant of each. The selections included parent plants of small, medium, and large boll types. Early, rapid-fruiting defoliate strains with medium bolls and early, rapid-fruiting nondefoliate strains with large bolls have been developed in this breeding work. Cottons for best results on very different soils and climates must be bred and developed on soil typical of the region where they are to be grown.

EARLY-MATURING DEFOLIATE COTTON.

In this work of breeding early cottons some strains matured their plants extremely early and shed their foliage a considerable time before frost. Two strains of this character, defoliates, are exhibited in figure 12. See also Table I, Nos. 65, 129, 39, and 55. These cottons deprive weevils of food and places for propagation and under certain conditions reduce the number of weevils at the latter end of the growing season which will go into hibernation and appear the next season.

This character at first seemed to offer useful possibilities in this respect, but in order for it to be effective the time between the maturity of the plants and the first frost must be sufficient to decrease the number of weevils by starvation and to prevent their propagation. The length of the growing season is not the same throughout the cotton belt or in the same place in all seasons, and therefore the period of fruiting of this cotton would of necessity have to be shorter in some sections or seasons than in others. Furthermore, such cottons, to be effective as regards the weevil, must have a limited period for making fruit, and as the seasons are not of the same length in different parts of the cotton belt and as climatic conditions prevent the weevils from being as numerous in some years as in others it is the conclusion of the writer, after developing and growing cottons of short and of long fruiting periods, that a cotton with a short fruiting period will not yield any more when weevils are numerous and will yield less when weevils are not numerous than a cotton with a longer fruiting period. Were there no winter season in the American cotton district to reduce the weevils, these very early maturing defoliate cottons would perhaps be of essential importance in reducing them.

Variation in rainfall and the occurrence of drought, high heat, a late spring, and early frost, together with irregular and indifferent planting and cultivation, are conditions that largely affect the crop. A cotton plant to yield a maximum amount under such varying conditions must not have a short and fixed fruiting period, but must begin fruiting early in the season of growth and must fruit rapidly and continue to set fruit until its growth and fruiting are brought to a close, as they will be when the weather conditions and length of season are normal by its inherent tendency to mature under the influence of its strong reproductive process acting upon the vegetative process and also by the influence of high heat and decreasing moisture. This early, rapid-fruiting cotton when planted early comes to some degree of maturity every season, but the degree of maturity varies with the time of planting and the climatic conditions that prevail toward the close of the growing season. It deprives the weevil under normal conditions of both food and squares to some extent and yet makes a maximum yield under the varying conditions. The early, rapid-fruiting, defoliate cotton yielded as much in 1907 when weevils were very numerous as the early, rapid-fruiting, nondefoliate or persistent fruiting cotton, but the latter yielded more in 1906 when weevils were not so numerous. The early-maturing defoliates Nos. 39, 65, 129, and 55 grew smaller, as may be seen in Table I, and yielded well, but produced less in 1906 than those progeny rows that were a little later in maturing. The latter never completely defoliate, but they practically stop growing and making squares before frost when planted early on upland at the place where developed, College Station, Tex. The indifferent planting and cultivation practiced on many farms would be more harmful to short-fruiting cotton than to longer fruiting cotton. The long-fruiting period of the cotton plant is the factor that has for all time enabled every degree of poor farming to produce cotton.

RESTRAINING RANK VEGETATIVE GROWTH BY SEED SELECTION.

On rich bottom land, growers have trouble on account of their cottons growing too rank or large. The lower bolls rot more or less and the plants grow out of all proportion to their yield. Seed selection was made to determine what could be done to restrain the size of plants. The selections were made in the King and Jones varieties and in an unknown variety. These cottons were growing on very rich river bottom land and the stalks were 7 to 9 feet tall. By careful search small plants were found of the King and Jones varieties, from 2½ to 3 feet in height and very full of open bolls. In the unknown variety there was very little difference in the height of the plants and no very small plants could be found.

Seeds were taken from the very small and from the large plants and in the following spring they were planted on bottom land and on hill land. The stand on the bottom land was destroyed by unfavorable weather, but the planting on the hill land or upland grew and exhibited the characters of the parents. The progeny of the small King plants grew to be 2 feet tall. The progeny of the large King plants grew to 3¾ feet tall. The progeny of the Jones variety from small plants grew to 2¼ feet tall and from large plants to 3¼ feet. The progeny of the unknown variety, in which no small plants were found, exhibited little difference in height. This lack of difference in the height of the progeny was in conformity with the parents of the unknown variety. In the King and Jones varieties the small progeny plants were more fruitful than the large ones. The latter had very long joints.

These differences in the progenies would undoubtedly have been greater if the plants had grown on bottom land. The conditions there would have favored and continued the strong vegetative growth of the large plants.

Growers may by seed selection limit the size of their plants either on bottom land or upland, and in doing so make them more fruitful. The selection must be from very small and fruitful plants.

CROSSING OR HYBRIDIZING.

Crossing is not difficult, though it is sometimes so regarded. Some growers have thought crossing to be the first essential to the improvement of the economic qualities of a staple crop, such as cotton. Crossing one plant with another is accomplished by simply transferring pollen of the flower of one plant to the receptive stigma of the flower of another plant after having first removed the pollen of the latter, if a self-fertile flower, to prevent its fertilizing the stigma. The flower is then covered to prevent fertilization from other sources. Cross-if the moisture or rainfall permits. This treatment when it can be given dries and opens the soil, admits air and warmth, and aids the cotton in its resisting power and in growth until the weather conditions become more favorable. A light wood-frame side harrow, weighing not over 35 pounds, with either "duck foot" or plain harrow steel teeth, is the best tool.

When the seeds are planted in a sweep furrow the stand of young cotton is often lost in a wet, cold spring on account of the lack of drainage. This is especially true in sandy soils.

SOME EXPERIMENTS AND OBSERVATIONS.

On March 20, 1906, 20 acres were planted with nearly a bushel of seed to the acre, the seed being covered with about 2 inches of soil. As the soil was warm germination began very promptly, but a moderately heavy rainfall, followed by a few days of cold weather, destroyed all the seed in the soil.

On April 10, 1906, these 20 acres were replanted at the rate of 1 peck to the acre, the seed being covered from one-half to three-fourths of an inch, and at the same time 6 acres were planted and the seed covered about 2 inches. A stand was obtained on the 20 acres where the seed was lightly covered, while not so good a stand came on the 6 acres, but no cold, wet weather followed these plantings to affect the seed which was covered 2 inches.

The month of April, 1907, was colder than March, and in the first week of April 20 acres were planted at the rate of 4 pounds of seed to the acre. A good planter was used, and the covering was not over three-fourths of an inch in depth. All the seed came up and lived. In 1906, some of this land was in sorghum, some in corn, and some in cotton. The roughest of the land was the corn land, and because of its open nature, due to stalks and grass and the absence of winter rains, some of the young cotton plants died, their roots not being able to come in contact with firm soil. Where the seed bed was firm none of the plants died. This experience shows the importance of a firm seed bed.

On 3 acres of land selected seeds were hand-dropped in 1907, one seed every 3 feet, and scarcely covered. All the seeds came up except where occasionally a seed was covered too deeply. This planting on April 12 was followed by two weeks of cold and rain that would have prevented deeper covered seed from coming up.

There is generally more moisture in the soil to germinate and bring up early-planted seed than there is later in the season, and there would always be sufficient moisture to bring up the early-planted seed if the soil or beds were harrowed so as to hold moisture and destroy weeds and grass till planting time.

Very little warmth is required to germinate early-planted seed that is lightly covered.

Where the seed bed is not firm it is practically impossible to cover early-planted seed to the right depth. It is also practically impossible to cover early-planted seed to the right depth when the covering is done with small plows on the planter unless they are so constructed as to prevent them from going too deep, an almost impossible thing to do, especially on a one-horse planter.

For growers to carry out successfully these suggestions as to shallow covering and keeping a stand in early planting, three things are necessary:

(1) The seed bed must be firm and clean.

(2) The soil of the beds must be harrowed before planting and cultivated shallow while the seeds are coming up, if necessary, and as often thereafter as moisture permits.

(3) The planter used must be of the right type.

It is necessary to have a gauge wheel in the rear of the planter to regulate the depth of planting and to press the seed into direct contact with the firm undersoil, so that the soil moisture can enter the seed.

All planting seeds should be as free from lint as it is possible to gin them. They can then come in contact with the soil and readily absorb moisture and will germinate more quickly.

These results are given for early planting only and in rainy districts. Late planting is not to be considered in weevil districts and is therefore not discussed.

Seed planted early escapes the heavy packing rains that come later in the season, and when the planting is rightly done a stand is more certain than from late-planted seed.

An early stand of cotton is so important where boll weevils and bollworms are present that a cotton grower can not afford to neglect anything that will aid him in securing and maintaining an early stand.

SUMMARY.

Productive cotton is important regardless of the weevil, but under weevil conditions the planting of early, rapid-fruiting, productive cotton is imperative for the making of a profitable crop. The method of seed selection recommended may be followed by growers outside of the weevil district as well as by those within the infested territory.

By applying this method in selection, slow-growing and unfruitful plants are eliminated and the selected seed will produce an increased yield of seed cotton, an increased proportion of lint to seed, and a better quality of lint or fiber.

The cost to the cotton grower to make a general seed selection and propagate enough seed in a patch to plant 100 acres of general crop will not exceed $5.

While growers are able to improve their own cotton by applying the method of seed selection described in these pages, yet the recommendation is made that they secure seed from breeders or from other sources whenever seed superior to their own can be obtained.

Early planting is essential to the making of a full crop under boll-weevil conditions, and the treatment recommended for insuring a stand does not require any extra expense. By planting the seed very shallow, less than an inch, on a firm seed bed, an early stand can be secured and maintained.

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FARMERS' BULLETIN 315.

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PROGRESS IN LEGUME INOCULATION.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., December 4, 1907.

Sir: I have the honor to transmit herewith a paper entitled "Progress in Legume Inoculation" and to recommend that it be published as a Farmers' Bulletin. This paper was prepared by Mr. Karl F. Kellerman, Physiologist in Charge of Soil Bacteriology and Water Purification Investigations, and Mr. T. R. Robinson, Assistant Physiologist.

Although this paper contains considerable new material, it is practically a revision of Farmers' Bulletin No. 240 and is intended to supersede it for general distribution.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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PROGRESS IN LEGUME INOCULATION.

INTRODUCTION.

The peculiar value of legumes for maintaining and increasing the fertility of soils is due to certain bacteria which develop nodules upon the roots of leguminous plants and which have the unique power of rendering the free nitrogen of the atmosphere available for plant growth. Without these bacteria, legumes, like other crops, exhaust the soil of its combined nitrogen. In many regions certain types of these important bacteria are abundant in the soil; in other localities they must be imported, either by distributing soil from a field where they are known to be present or by using pure cultures of the proper organisms grown under artificial conditions. The old method of importing the bacteria by distributing soil from fields containing them is not only expensive but there is very great danger of spreading weeds and destructive crop diseases as well as the desirable bacteria. Under modern conditions, therefore, it is wisest to depend chiefly upon the intelligent manipulation of pure cultures for inoculating leguminous crops.

THE USE OF PURE CULTURES OF NITROGEN-GATHERING BACTERIA.

Recent improvements in the methods of preparing and distributing pure cultures for inoculating leguminous crops have obviated many of the difficulties previously experienced in their use. The directions for handling by the planter have been simplified and adaptations have been made to meet varying conditions of field and plat experiments. The directions accompanying the cultures distributed under the present plan may be summarized as follows:

For cultures that are to be increased by the planter, in one gallon of clean water, boiled and cooled, is dissolved a small quantity of sugar and the tablet which is supplied with the small bottle of culture. The liquid culture in this small bottle is poured into the gallon of solution and the mixture is allowed to develop for twenty-four hours at a temperature of about 70° F., and is then ready for use.[a] The seed should be thoroughly moistened with this culture, without being soaked, and should then be spread out to dry in a clean, shady place. It is an advantage, though not an absolute necessity, to dry immediately by mixing with the moist seed a small quantity of dry, sifted earth. Planting should follow as soon as practicable, using the same methods as for untreated seed.

It is sometimes desirable to treat the soil direct instead of treating the seed. The solution is then mixed with enough dry soil (preferably from the field to be inoculated) so that it will just moisten the soil. This treated soil is again mixed thoroughly with a larger quantity of soil—say, half a wagonload for an acre. The inoculated soil is then distributed evenly over the prepared ground and should be harrowed in at once to avoid exposure to sunlight.

In special cases the amount of culture supplied is largely increased, and this is to be used immediately instead of waiting twenty-four hours for development. If the quantity of seed to be treated does not exceed 12 to 15 pounds the user has simply to open the bottle at once and pour the contents upon the seed. If more liquid is needed to moisten a larger quantity of seed, water up to 1 gallon may be added, reckoning 1 quart to a bushel of seed.

APPLICATIONS FOR CULTURES.

As cultivated soils in any one place are usually well supplied with the nodule-forming organisms adapted to inoculate the legumes that have been grown successfully for many years in that region, very little benefit will be obtained from further inoculation. To guard against useless experiments and to make those carried out of value for future guidance, the applicant for inoculating material is required to fill out a blank form which asks for information in regard to the legume to be treated, date of planting, soil conditions, etc.

On the reverse of the application form a circular letter gives briefly the plan of the distribution. Attention is called to the fact that the bacteria are beneficial only in connection with legumes, such as the various clovers (including alfalfa), vetches, peas, and beans, and are not applicable to other farm or garden crops.

REPORTS OF RESULTS.

It is expected that each one who secures a culture for inoculating legumes will follow the directions carefully and report the results, whether a success or a failure, to the Bureau of Plant Industry. Blanks for this purpose are furnished at the proper time. The main facts desired for this report are quantity of seed (or area) planted and date of planting; whether the culture was applied to the seed or soil; how the land was fertilized; whether it was new land, an old field, or garden soil; the kind of crop previously grown; and whether the culture when applied was clear, faintly clouded, milky, or frothy.

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[a] One gallon will treat at least three or four bushels of seed.

As to results, the roots should be examined to determine whether the nodules are present or absent and should be compared, if possible, with plants grown on ground not inoculated. In making this examination care should be taken in *digging* the plants not to detach the small root hairs. Plants simply pulled from the ground will usually be stripped of nodules along with the broken-off rootlets. Even with careful digging in compact soil it is necessary to examine the clumps of soil about the roots as well as the roots themselves. Any unusual conditions which appear to have affected the results of the experiment should be mentioned especially, together with information as to the general appearance and yield of the inoculated crop compared with the uninoculated portion or with previous experience with the same legume.

THE EFFECT OF SOIL CONDITIONS UPON LEGUME BACTERIA.

In the investigation of the results of inoculation the wide range of soils for which cultures have been furnished has brought out the complexity of the subject and developed many special problems. The constitution or character of the soil itself has been found to have an effect upon the growth of nodule bacteria, as well as upon the formation of nodules.[a] Some soils have a chemical composition distinctly unfavorable to the development of the introduced bacteria; other soils are so compact or retentive of moisture as to exclude air and thus be unfavorable to the growth of the bacteria and to nodule formation.

A study was made of the reports received from experimenters who used cultures for inoculating legumes to correlate, if possible, type and condition of soil, treatment, legume species, etc., for those showing favorable results and those showing unfavorable results. Two representative and widely grown legume crops were studied in this way—alfalfa and red clover. The only selection made in the reports chosen for this study was in taking all those received during the two calendar months of November and December, 1906. These were classified (as illustrated in the reports quoted on pages 15 to 19) into "successes" and "failures." The third class, of "doubtful" character, is not included in this statistical study. Success, as here used, means an observed increase in nodule formation showing benefit to the crop, while a failure is scored when attempted inoculation failed to produce nodules or produced so few as to be of no advantage to the plant. When natural inoculation proved abundant the experiment was set aside as inconclusive, as were also crop failures reported as due to poor seed, decidedly adverse season, and other factors clearly apart from the influence of inoculation. The reports, about one thousand in all, have been carefully studied, and the influence of the various factors upon nodule formation is expressed in terms of percentage in the following table:

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[a] For a discussion of this, see Bulletin 100, Part VIII, of the Bureau of Plant Industry, U. S. Department of Agriculture.

TABLE I.—*Percentages of successful and unsuccessful inoculations under different soil conditions during November and December, 1906.*

Conditions of experiment.	Alfalfa.		Red clover.	
	Successes.	Failures.	Successes.	Failures.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
On new ground	81	19	95	5
On sand or sandy loam	75	25	87	13
On loam	70	30	88	12
On clay or clayey loam	65	35	92	8
On fallow or sod turned under	69	31	91	9
On old cultivated field soil	64	36	90	10
Crop new to the region	61	39	92	8

An examination of the data here shown does not warrant general conclusions of a positive character. Apparently none of the physical conditions reviewed are of great importance in determining the success or failure of inoculation. For the present, therefore, we must assume that such differences as exist in these particular cases, making one soil more favorable for inoculation than another, are, in part at least, biological, requiring more detailed investigation and experiment.

It is doubtless true that the cultures themselves have not always been in the most effective state at the time of use. With the safeguards observed at each point in their preparation and distribution, however, the cultures as they go from the laboratory are in a high state of efficiency. To secure the desired results they must of course be handled according to directions.

THE EFFECT OF INOCULATION UPON THE COMPOSITION OF THE CROP.

In some cases where there has been apparent failure to improve the legume crop, further examination may show a decided gain from inoculation. Even where the lack of nodule formation does not seem to hinder a healthy development of the plants careful comparisons from analyses have shown the greater protein content of those well supplied with nodules. The amount of nitrogen contained in a soy bean crop[a] was found in one case to be 113.55 pounds to the acre for the inoculated plants and 75.98 pounds to the acre for those not inoculated, yet the appearance in the fields was the same. With cowpeas, inoculated and uninoculated, the nitrogen was found to be 139.21 pounds to the acre for the former and 118.45 pounds for the latter. In each case, therefore, the inoculated crop, although apparently not improved, was in reality much more valuable for feeding or for green manure than the uninoculated crop.

In addition, it should be noted that with the inoculated plants the gain of nitrogen came largely from the air, while the plants lacking nodules drew upon the combined nitrogen of the soil. When the gain in nitrogen from inoculation is accompanied by largely increased plant growth the beneficial effect of nodule formation is, of course, most pronounced. Some chemical analyses[b] of Canadian field peas, inoculated and uninoculated, serve to show in a striking manner the comparatively rich growth of the inoculated peas. The plants bearing nodules had a nitrogen content of 2.29 grams per 100 of dry substance; the plants without nodules grown in the same soil had 1.60 grams per 100 of dry substance. The average dry weight of inoculated and uninoculated plants was 11.2 and 2.3 grams, respectively. It is evident, therefore, that the inoculated plants supplied more than seven times the amount of nitrogen furnished by those not inoculated, viz, 0.255 gram to the plant, as compared with 0.035 gram to the plant.

Similar results were obtained with wild hemp plants (*Sesbania macrocarpa*), inoculated and uninoculated.[c] Analyses[d] of the nodules themselves and of the roots from which the nodules were removed show that, though the noduled plants made a decided gain in nitrogen in both roots and tops, by far the highest percentage of nitrogen was found in the nodules themselves. The following table shows these figures in detail:

TABLE II.—*Occurrence of nitrogen in inoculated and uninoculated plants of the wild hemp.*

[Grams of nitrogen per 100 grams of dry substance.]

1. Roots, stripped of nodules	1.50
2. Nodules (from No. 1)	6.40
3. Tops (from No. 1)	2.09
4. Whole plants (inoculated, having numerous nodules)	3.01
5. Whole plants (not inoculated, no nodules)	1.71

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[a] Grown at Agricultural College, Mich. For description, see Bulletin 224 of the Michigan Station.

[b] Analyses made by the Bureau of Chemistry, U. S. Department of Agriculture.

[c] Experiment carried on by Mr. David Fairchild, in charge of Seed and Plant Introduction for the Bureau of Plant Industry.

[d] Analyses made by the Bureau of Chemistry.

In view of the generally recognized importance of nitrogen to the growth of plants[a] the significance of the foregoing facts needs little emphasis. A difference between abundant nodule formation and the absence of nodules, which may affect the value of a legume crop in the ratio shown, can not fail to command attention when its bearing on successful farming is once realized. It is not enough merely to count yields in pounds or tons. The composition of crops for feed or green manure becomes in the light of these investigations a factor of importance.

GREEN MANURING AND INOCULATION.

Generally speaking, the experience of scientific farmers and the tests of agricultural experiment stations agree in ascribing an unusual benefit to succeeding crops from green manuring with leguminous crops, and this is clearly due in considerable degree to the nitrogen fixed by the root nodules and not to the length of the root system or other peculiarities of leguminous plants. Unfortunately, investigators have not given sufficient attention to the relative abundance or scarcity of nodules when experimenting with different leguminous crops for green manures. From the preceding data it is evident that legumes reach their maximum value as green manures only when abundantly supplied with nodules.

CONFUSION OF NEMATODE GALLS WITH NODULES.

Nematode galls, or root knots, are often mistaken for nodules, which they resemble in appearance. The nematode gall is extremely injurious, and in regions where it has been known to exist it is unwise to plant crops favorable to the development of the pest. Nearly all of the legumes should be avoided in such cases. This is important not only because the legumes susceptible to nematode attack are themselves injured, but chiefly because they furnish conditions favorable to the rapid development and multiplication of the nematode worms, and these may become a serious menace to succeeding crops or to orchard stock, which under ordinary conditions they would scarcely injure. There are, however, some resistant varieties[b] upon which the nematode worm can not devolop, and in infested regions these resistant varieties should be used exclusively. If a leguminous crop with its roots covered with what are apparently nodules makes a sickly growth, or if there is doubt as to whether a legume is inoculated or infested with nematodes, samples for examination should be forwarded to the Bureau of Plant Industry of the Department of Agriculture.

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[a] See Bulletin 247 of the New York (Ithaca) Agricultural Experiment Station.

[b] The most important and generally useful resistant variety is the Iron cowpea (*Vigna sinensis*). In the Southern States the velvet bean (*Mucuna utilis*) and Florida beggarweed (*Meibomia mollis*) are valuable.

WHEN INOCULATION IS DESIRABLE.

Inoculation is desirable—

(1) If the soil has not previously borne leguminous crops.

(2) If legumes previously grown on the same land were devoid of nodules.

(3) If the legume to be sown belongs to a species not closely related to one previously grown on the same soil.

(4) If the soil produces a weak growth of legumes, even though their roots show some nodules.

It is significant of the relative value of pure culture inoculation that a high percentage of beneficial results is being obtained, not only where legumes new to the region are being tried, but where the ordinary legumes used in rotation have been inoculated, a phenomenon which is undoubtedly due to the increased virility of the nodule-forming bacteria resulting from the proper development of the pure cultures in the laboratory. It is also true that the crops following the inoculated legumes have in many cases shown gains not evident in the legume crop. The practice of inoculating is therefore justified where legumes are naturally inoculated but do not seem to reach their full vigor nor to give the best results as green manures.

WHEN INOCULATION IS USELESS.

Inoculation is of no value—

(1) If the legumes usually grown are producing average yields and the roots show nodules in abundance.

(2) If the soil is in such condition as to prevent the normal growth of the bacteria or of the leguminous plants.

(3) If the directions for handling the cultures are not studied carefully and followed intelligently.

(4) If the soil is acid and in need of lime. Liming to correct acidity is as important for the proper activity of the bacteria as for the growth of the plants.

(5) If the soil needs fertilizers, such as potash, phosphoric acid, or lime. The activity of the nodule bacteria in securing nitrogen from the air and rendering it available to the legumes will not take the place of such fertilizing elements as potash and phosphorus.

It must be remembered that inoculation will not overcome results due to bad seed, improper preparation and cultivation of the ground, and decidedly adverse conditions of weather or climate. Before attempting to inoculate a new crop the farmer should first inform himself thoroughly concerning the proper handling of the crop itself; otherwise failure is almost certain. As an illustration, sowing alfalfa on hastily prepared land, on land foul with weeds, and on acid soils or soils underlaid with hardpan, is contrary to accepted practice.

Free publications covering the essential points in growing all common legumes may be obtained from the State experiment stations and from the United States Department of Agriculture.

DANGER IN INOCULATION BY SOIL TRANSFER.

Very satisfactory inoculations have been obtained by transferring soil from old fields where legumes have been grown, but there are dangers incident to such soil transfer which should be noted.

The source of supply should be very definitely known, and in no case should soil be used from fields which have previously borne any crops affected with a fungous disease, a bacterial disease, or with nematodes. Numerous animal and plant parasites live in the soil for years and are established in so many localities that it is manifestly unwise to ship soil indiscriminately from one portion of the country to another.

Of scarcely less importance is the danger of disseminating noxious weeds and insect pests through this plan of inoculating by means of natural soils. Even though weeds may not have been serious in the first field, the great number of dormant seeds requiring but a slight change in surroundings to produce germination is always a menace.

If soil[a] is to be used, however, whether obtained from near-by fields or shipped long distances, the evidence should be clear that the soil is free from the objections mentioned above.

RESULTS OF COOPERATIVE FIELD TESTS.

The results of cooperative experiments with planters throughout the United States, begun in the spring of 1906 and reported upon during the autumn of that year, are presented here in tabular form. These reports are divided into three natural classes: Successes, doubtful results, and failures. To explain further the plan followed in this tabulation, quotations from representative reports under each class are given.

An examination of these sample reports will show that the successes credited to the culture have been so recorded only when a clear gain was shown to be due to inoculation. A less strict interpretation of the doubtful reports would place many of them in the column of successes, and undoubtedly many classed as failures to secure inoculation would prove upon adequate investigation to have been failures from causes other than deficient nodule formation.

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[a] The quantity of soil from a thoroughly inoculated field regarded as sufficient for inoculating an acre of land for alfalfa, for instance, is variously placed at 200 to 500 pounds.

TABLE III.—*Results of experiments with crops sown in connection with cultures of nitrogen-gathering bacteria in the spring of 1906.*[a]

Crop.	Successes.	Doubtful results.	Failures.	Total.
Alfalfa	403	657	182	1,242
Red clover	498	544	66	1,108
Garden pea	236	209	54	499
Garden bean	217	224	74	515
Cowpea	247	208	53	508
Canadian field pea	44	27	10	81
Vetch	16	19	4	39
Soy bean	23	40	23	86
Crimson clover	8	18	2	28
Sweet pea	22	29	8	59
Velvet bean	10	14	2	26
Alsike	33	24	3	60
White clover	2	2	0	4
Peanut	10	19	1	30
Bur clover	0	1	0	1
Beggar weed	0	1	3	4
Japan clover	1	0	0	1
Mung bean	0	1	0	1
Sainfoin	0	2	4	6
Sweet clover	0	3	0	3
Total	1,770	2,037	489	4,296

[a] Approximately 8,000 cultures were sent out. A little more than half of the recipients had reported results at the time this table was prepared. The general relation remains about the same, as additional reports have been tabulated since this table was prepared.

REPORTS OF INOCULATION EXPERIMENTS CLASSED AS SUCCESSES.

The following are examples of the experiments with nitrogen-gathering bacteria which have been classed as successes:

Alfalfa.—"Nodules are numerous on inoculated ground, while I fail to find any on uninoculated. The inoculated crop did fine, while the uninoculated was a failure, and always has been so far." (Ballagh, Nebr.)

Alfalfa.—"I find roots well filled with nodules. Alfalfa has a good dark-green color and grows thriftily, whereas in previous experiments it has kept small and yellow for the first three years. I cut three fair crops this year, although the rainfall was somewhat deficient." (Waupaca, Wis.)

Alfalfa.—"Quite a lot of nodules on inoculated plants and a very good stand; looks fine. Strip 30 feet wide and 400 feet long not inoculated has very poor stand and very few nodules." (Cleveland, Ohio.)

Red clover.—"The inoculated crop is of a strong and thrifty growth. All the seed that I sowed that was not inoculated died in forty to sixty days after planting, as did every clover field in this vicinity. There was a marked difference in the inoculated and uninoculated from the start; the inoculated seemed a better color and did not die out from the dry weather as the other did." (Paris, Mo.)

Red clover.—"By count I find from two to four times the number of nodules on inoculated area. I inoculated 20 acres; used commercial fertilizer on an adjoining 20 acres, and on a third 20 acres nothing was used. One week ago on the inoculated area was to be seen clover of a much darker color and of twice the growth found on fertilized area. The results were highly satisfactory in every respect." (Lima, Ohio.)

Red clover.—"Roots covered with nodules. Clover on adjoining land, but better land, very poor. Inoculation certainly did increase the nodules and, of course, improved the crop. Clover sown last spring in this vicinity is poor, but mine sown upon high sand hills is all that I can ask; it exceeds my expectations. I am convinced that it is useless to sow clover on this ground without inoculation." (New London, Wis.)

Cowpea.—"The growth of nodules was fully 200 per cent better on the inoculated than on a small portion that was not inoculated. The increase of peas over the uninoculated was fully three to one. The increase of hay I did not take into close consideration, but on a fair estimate, I think, about 2½ tons an acre in favor of inoculated." (Buttonwood, Pa.)

Cowpea.—"There was a good supply of nodules on the inoculated plot, one plant having a good handful of large size at harvesting time. There were no nodules on three plots of the same size that were not inoculated. The uninoculated plot (Whippoorwill) yielded 6½ pounds grain; the inoculated plot (Whippoorwill) 9 pounds grain." (Pataskala, Ohio.)

Cowpea.—"Planted one-half acre in same field, using no culture; both had 500 pounds of same fertilizer per acre. Compared with roots where culture was used, found less nodules and turned down scant growth of pea vines to sow scarlet clover and rye. Where culture was used, found large number of nodules and rank growth of vines which remained green until peas matured and yielded 20 bushels per acre. Land now seeded to rye and scarlet clover, which is looking fine." (Withans, Va.)

Cowpea followed by oats.—"On a part of the ground on which the treated cowpeas had been grown I planted oats. They turned out 50 bushels to the acre, and on ground where the untreated cowpeas had grown they turned out only 25 to 30 bushels to the acre, no other fertilizer being applied to either piece of ground. Fields just adjoining mine have yielded only 25 bushels an acre." (Hammond, La.)

Cowpea followed by oats.—"I made up with supplies sent me from the Department 100 gallons of liquid culture, which was distributed among 20 farmers in this vicinity. Those who planted peas for forage have gathered twice the quantity of pea-vine hay from the ground in which the inoculated seed were sown. I repeated last year's experiment in following the peas, after the hay had been cut off, with oats in drills. So far as the eye can judge, the improvement in the oat crop is proportionally as great as that in the crop of pea vines." Others in this same group of cooperators reported as follows: "Cowpeas are practically unknown here (a large body of land in a bend of the Coosa River) and when sown last season without inoculation no nodules were formed. The bacteria secured largely increased the yield; 3 tons of hay from an acre of inoculated seed, one-half ton from uninoculated seed; made twice as many peas on land inoculated as on land not inoculated. Season too wet to gather peas." (Rome, Ga.)

Cowpea followed by corn.—"Where cowpeas were grown last year we have corn this year. The field is a 4-acre lot and includes sandy gravel as well as good rich loam. Over the entire portion where the cowpeas were grown with the culture the corn has a rich black color; on the area where no culture was used there is a distinct difference, the corn being smaller and not of such dark color. This is very distinct, even on the heavy loam. The growth of cowpeas was estimated at twice as much last year where the culture was used as where there was none. The cowpea crop was cut last year, but on account of continual rains was left on the ground and plowed under."[a] (Vineland, N. J.)

Bean.—"Nonculture beans grew slowly, were light green (though not unhealthy), and had slender stem and sharper pointed, more delicate-looking leaf. Culture beans grew rapidly, were stout and deep green, and the leaves were thicker and blunter pointed. Nonculture beans bore ordinarily well, and after one bearing rusted and dried up. Culture beans were loaded, kept putting forth blossoms, and bore until frost killed them in October. On the roots of the nonculture beans there were a few minute and hard-looking nodules, and the roots were small and weak. On the roots of the culture beans the nodules were plentiful and juicy; the roots were long and vigorous. On reading your account of seed raised in pure sand from inoculated seed, I thought I would try coal ashes, and planted three hills of two varieties in our last winter's ash heap, scooping out a hole, laying in the beans, and covering with mixed earth and ashes. They grew wonderfully and bore until frost, and at that time had a fourth crop of blossoms." (Woodfords, Me.)

Vetch.—"A strip 25 or 30 feet wide was sown without inoculation. That part inoculated showed roots full of fine nodules, while the plants uninoculated showed none at all. The growth in the part of the field that had received the inoculation was three or four times as great as in that part not so treated." (Irving, Mich.)

Vetch for citrus orchard.—"Vetch was tried three years ago and gives good results. Eighty per cent of our orchardists now plant legumes to plow under, and find it profitable. Inoculated vines about 20 per cent heavier than uninoculated on soil never having had a crop of legumes. Our soil is a heavy red clay adobe, formerly a desert, and devoid of humus." (Redlands, Cal.)

Garden pea.—"Planted inoculated and uninoculated side by side. Inoculated had many nodules and large ones; uninoculated few and small, and some plants none at all. Inoculated foliage dark green; uninoculated yellowish green. Stems longer and growth more vigorous on inoculated, yield about double that of the uninoculated." (Parkersburg, W. Va.)

Canadian field pea for citrus orchard.—"The pea vines plowed under furnished orange and lemon trees with plentiful nitrogen. Fruit trees were never so vigorous as now. Where we did not inoculate we got less vine and nodules, and fruit trees are not so fine." (Glendora, Cal.)

Canadian field pea.—"Nodules well developed. No nodules on an adjacent uninoculated crop which, excepting inoculation, received the same treatment. Peas and hay much increased (nearly doubled) over adjacent uninoculated crop." (Mount Pleasant, N. J.)

Canadian field pea.—"The cultures were applied to one ton of peas; the other half ton was planted without inoculation. The nodules on plants from the inoculated seed were larger and twice as numerous as from the uninoculated. The inoculated crop was much more robust and thrifty. The planting was done in a foothill orange orchard with steep gradients. The purpose of the planting was to prevent washing, as well as for fertilization. I planted the inoculated seed in one direction and the uninoculated crossing it in open spaces at right angles. The result was a decided checkerboard, with inoculated seed producing a crop twice as vigorous and high as the other." (Glendora, Cal.)

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[a] The yields from these two portions were reported later as follows: Corn following uninoculated cowpeas averaged 75 bushels an acre; corn following inoculated cowpeas averaged 105 bushels an acre. These figures are for corn on the ear.

Soy bean.—"Inoculation increased nodules. On part of ground I spread soil from a soy-bean field; on part I planted seed with inoculating cultures; part of the field had no soil or inoculated seed. Both inoculated seed and soil from a soy-bean field caused vigorous growth of nodules; no nodules on ground not treated. Inoculated crop was dark green in color; uninoculated light green. Where soil was fertile the growth was about equal, but where soil was poor the growth of the inoculated bean was more than double that of the uninoculated." (Cazenovia, N. Y.)

Peanut.—"I planted one gallon of seed not treated through the center of the lot, making 14 rows. They were very inferior, with nodules about 50 per cent in number and about one-half the size of those treated. I consider the gain for the inoculated crop at least 100 per cent." (Winterpock, Va.)

Sweet pea.—"About one-third of plot I did not inoculate. In this area I could not find a single nodule, though the roots of the inoculated portion were literally loaded with them. The whole plot was manured the same and had the same treatment all the season. The vines on the inoculated portion were more rank and would weigh three or four times as much apiece as those on the uninoculated portion. There were noticeably more and better blossoms from the inoculated plot." (Townsend Harbor, Mass.)

Crimson clover.—"Inoculated clover had five times the number of nodules as that not treated; in fact, they were perfect. Two acres uninoculated did not have as much clover as 10 square feet where treated. The appearance of inoculated field is fine—stalks large and healthy; stalks on uninoculated portion small and few." (Manheim, Pa.)

REPORTS OF INOCULATION EXPERIMENTS CLASSED AS "DOUBTFUL."

The following are examples of reports which have been placed in the doubtful class:

Alfalfa.—"There is a good amount of nodules on roots. No other field of uninoculated alfalfa here; so I can not compare. General appearance good." (Jefferson, Oreg.)

Alfalfa.—"Could see no difference between the inoculated and uninoculated; first cutting, considerable weeds; second cutting averaged 1 ton per acre good alfalfa." (Floyd, Tex.)

Alfalfa.—"I failed to secure a stand; the wind blew the ground so that the young plants were destroyed." (Hansford, Tex.)

Alfalfa.—"I am sorry to report alfalfa was an entire failure, I think on account of ground being too wet." (Canisteo, N. Y.)

Red clover.—"This field has never had a very good stand of clover and it does not seem much better this year. Examined plants from both parts of field and both seemed to have plenty of nodules; possibly more plants and more nodules on inoculated portion." (West Chester, Pa.)

Red clover.—"Can not tell as to results. We had six weeks of dry weather, and my seed did not come up." (Mohemenco, Va.)

Garden pea.—"A very wet season made the crop a failure. No conclusions could be drawn." (Hanover, N. H.)

Garden pea.—"Very few nodules noticeable. No increase in crop; perhaps the culture had been mixed too long before being applied to seed—had stood about ten days." (Hanover, N. H.)

Cowpea.—"Roots full of nodules; peas grew rank whether inoculated or not. The cowpea seems to grow here so well that I do not think artificial inoculation any benefit when the season is wet and warm, as it was this year." (Millersville, Md.)

Cowpea.—"I could not tell much difference between inoculated and uninoculated. Owing to excessive rain, the peas were almost drowned out, and it was not a fair test." (Greensboro, N. C.)

Cowpea.—"I can not tell very much difference in quantity of nodules on inoculated and uninoculated seed; if there was any difference, it was in favor of the treated seed. The appearance of the treated seed is darker than untreated." (Valle Cruces, N. C.)

REPORTS OF INOCULATION EXPERIMENTS CLASSED AS FAILURES.

Examples of results classified as failures follow:

Alfalfa.—"The nodules were not present at any time. The plants grew nicely for a time, then died, as they did formerly on an adjoining plot of land. No crop of alfalfa ever matured on this or any adjoining lands." (Rome, Tenn.)

Red clover.—"Could not find any nodules on either inoculated or uninoculated crop. It is the first clover ever sown on that field; it has been in wheat and corn for thirty years. Got a good stand, but it is mostly small, except where stable manure was spread." (McMinnville, Tenn.)

Cowpea.—"I examined peas on all parts of my place and found but few nodules. I could find no difference in the treated and untreated seed. I am inclined to think my inoculation was not right when I used it. My land appears to be without the proper bacteria; nodules are almost entirely lacking, and of course I can get but little results from my pea crop." (Moro, Ala.)

Soy bean.—"Plants were carefully dug, but had no sign of nodules, either treated or untreated. Culture may have been beyond the milky state but did not appear frothy. Good rank root system but no nodules." (Higganum, Conn.)

Garden bean.—"I examined the roots at different times and found only two nodules on the roots, and they were imperfect in appearance. There was no perceptible difference between inoculated and uninoculated." (Reedsville, W. Va.)

Garden pea.—"No nodules on either inoculated or uninoculated; no difference in growth. Extremely dry weather seemed to be the only cause for this being the poorest crop I have ever grown." (Ashland, Va.)

Vetch.—"Inoculation had no effect; total failure; no difference; soil, sandy loam, very poor and hungry." (Anamosa, Iowa.)

SUMMARY.

1. Abundant nodule formation improves the chemical composition as well as increases the quantity of a leguminous crop.

2. Leguminous crops with nodules are more valuable as green manure than leguminous crops lacking nodules.

3. Nematode galls or root-knots resemble nodules in appearance, but they are very injurious and care should be taken not to confuse the two growths.

4. It is wisest to depend upon pure cultures for inoculating purposes. If soil is to be used, however, great precautions should be taken in selecting and handling the soil to guard against the introduction of weeds or plant diseases.

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FARMERS' BULLETIN 316.

Experiment Station Work,

XLIV.

Compiled from the Publications of the Agricultural Experiment Stations.

DISTRIBUTING MANURE AND FERTILIZERS.
WINTERKILLING OF PEACH BUDS.
COLOR OF APPLES.
RINGING HERBACEOUS PLANTS.
POTATO SCAB.
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COOKING CEREAL FOODS.
SILAGE MAKING.
HORSE-FEEDING TESTS.
SUPPLEMENTS TO CORN FOR HOGS.
TANKAGE FOR HOGS FOLLOWING CATTLE.
HOPPERS FOR POULTRY FEEDING.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

DISTRIBUTING MANURE AND FERTILIZERS.[b]

In a bulletin dealing with the use of fertilizers in Mississippi, E. B. Ferris, in charge of the substation at McNeill, makes, as a result of his experience, some practical suggestions of general interest regarding different methods of distributing manure and fertilizers. He states that "there are two general methods of applying fertilizers and manures—broadcast and in the drill. It is thought best to make very large applications broadcast. * * * Roughly speaking, we would say that any application of commercial fertilizers heavier than 1,000 pounds per acre would best be applied broadcast and any smaller amount in the drill."

USE OF THE MANURE SPREADER.

"A manure spreader is the best and cheapest means of handling barnyard manure, provided, of course, there is enough of this manure on the farm to justify one in investing about $100 in such a machine. These manure spreaders can be regulated to distribute uniformly almost any quantity of manure per acre, and will apply it either broadcast or in the drill. They can also be used for making heavy applications of commercial fertilizers."

PARKING.

The merits of parking as a means of distributing manure on light soils were tested at the McNeill substation in the following way:

In the fall and winter of 1902–3, 30 head of steers were penned on 5 acres of land and fed for one hundred days on cotton-seed meal and hulls. The troughs were moved at intervals so as to cause the cattle to distribute the manure as evenly as possible over the land, and several times during the feeding period the land was plowed to prevent the washing of the manure over the surface. The land being comparatively level, very little of this manure was lost, and the soil, being of a sandy nature, was not injured by the tramping of the cattle even in the wettest weather. The effect of this manure on subsequent crops has been quite marked, being practically as great in 1906 as it was in

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Mississippi Sta. Bul. 99.

1903, the first year after the work was done. * * * The average yield of cotton on the unfertilized soil (at McNeill) has been 405 pounds per acre of seed cotton, while three years' results on this parked land show an average yield of 1,253 pounds per acre; the yield of cotton grown for four years continuously on the same land and fertilized with a mixture of two parts acid phosphate and one part cotton-seed meal at the rate of 300 pounds per acre has averaged 933.5 pounds of seed cotton per acre, while the average of three results with the same fertilizer on the parked land has been 1,840 pounds per acre; the yield of corn for three years has averaged 21.4 bushels more per acre on the parked land than on similar soils unmanured.

This shows that under favorable conditions of soil and climate parking may be a very cheap and efficient means of distributing manure.

USE OF THE FERTILIZER DISTRIBUTER.

"The best and most economical way of applying commercial fertilizers in the drill is by means of a fertilizer distributer." Mr. Ferris has tried and recommends a form of drill distributer looking very much like an ordinary cotton-planter, which will apply practically any quantity of fertilizer per acre from 100 to 600 pounds, and costs between $4 and $5.

HAND APPLICATION.

Mr. Ferris states that while a good proportion of the fertilizers used is applied by hand, wind is likely to make this method unsatisfactory. "A cheap tin fertilizer horn about 4 feet long and costing 20 to 25 cents enables one to do this work much better and with a great deal less stooping."

WINTERKILLING OF PEACH BUDS.[a]

Winterkilling of buds is the cause of frequent and large losses in peach growing. The injury is sometimes due to the starting of the buds before danger of late spring frosts has passed or to their swelling during exceptionally warm winter periods. By inducing trees to mature buds late in the fall the buds will not finish their resting period, and so will not be likely to start in the spring until danger of frost and cold is past.

In a recent bulletin of the Missouri Station W. H. Chandler reports the results of investigations which were undertaken to ascertain the effects of severe pruning and methods of training, thinning, and cultivation on the hardiness of peach buds and to determine the relative hardiness of different varieties. The more important of these results obtained are summarized as follows:

> It is well known that the vigor of growth of a peach tree can be increased by heading back, by cutting off a considerable portion of the ends of the branches in late winter or early spring when the fruit buds have all been killed.

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[a] Compiled from Missouri Sta. Bul. 74.

This is an excellent treatment to enable trees to recover from injury to the wood by severe winters.

The fruit buds formed on this vigorous growth of new wood in sections north of Missouri are more liable to injury from the cold of the following winter.

The buds on this vigorous new wood, however, finish their resting period[a] later and are therefore not so readily started into growth by warm periods in winter to be killed by cold periods following.

In Missouri, especially the southern half, there is in nearly every winter warm weather to start the buds into growth to a small or large extent.

In most of Missouri, then, fruit buds on trees that have made rather a vigorous growth, caused by reasonably severe heading back or by cultivation, are the less liable to winter injury. This has been true in the Missouri Experiment Station orchard and in others during each of the last two years.

Heading back may be too severe, however, since in any year the fruit buds most likely to come through the winter safely are those at the base of the whips of new wood, and if the heading back has been too severe the growth will be so dense that no fruit buds will be formed at the base of those whips.

In the experiment station orchard the trees having the smallest percentage of buds killed were those trained to a spreading, open head, and forced by pruning and cultivation to make a vigorous growth.

The fruit on trees with spreading heads does not rot so badly as that on trees with dense heads.

The fruit on trees making rather a vigorous growth, unless the growth is too vigorous, is larger than that on trees making smaller growth. This is true except with early varieties, where a tree making a rather small wood growth bears the better fruit.

Thinning the fruit enables the tree to set more hardy fruit buds for the next crop.

In the station orchard where only one side of a tree was thinned the side not thinned had from 5 per cent to 40 per cent more of its fruit buds killed by a temperature of 6° F. below zero on February 5, 1907.

Many varieties, like the Elberta, Crawford, Golden Gate, Oldmixon, and others, the fruit buds of which are known to kill badly in Missouri, do so because they finish their resting periods early and are therefore easily pushed into slight growth on warm days in winter.

Varieties of Chinese Cling and green-twigged types (excepting the Elberta, which has more the character of the Persian race) are generally late in finishing their resting periods and are, therefore, better adapted to the Missouri climate.

The results of these experiments show that in general those treatments which induce vigorous growth of new wood, prolonging thereby the resting period of the buds, lessen the danger of winter killing. It is thus seen that good cultivation, pruning, thinning, and the like, which are commonly employed to improve the quantity and quality of fruit, also tend as a rule to lessen the danger of winter killing referred to. In pruning, however, it should be remembered that the young whips produced are more sensitive to prolonged cold in winter than harder wood, and the trees should be headed back only into 2-year-old wood. The Missouri experiments indicate that the purple-twigged varieties as a rule finish their resting period earlier than the green-twigged varieties, and hence are more likely to be winterkilled, and this offers a possible basis upon which to develop more resistant and safer varieties.

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[a] **Plants generally have resting periods, a period when without special treatment they can not be forced into growth.**

EFFECT OF FERTILIZERS ON THE COLOR OF APPLES.[a]

The opinion is sometimes advanced in popular articles on the subject of apple culture that the use of such fertilizers as potash and phosphoric acid will improve the color of fruit. In cases where these particular elements are seriously lacking in the soil it seems reasonable to believe that their addition in some available form will promote a better all-around development of the fruit, color included, since both of these elements are known to be important constituents of the apple. On the other hand, scientific knowledge with regard to the real value of potash or phosphoric acid, or any other fertilizer, in improving the color of fruit appears to be too limited to warrant the apple grower in resorting to commercial fertilizer as a specific treatment for that purpose.

In this connection experiments conducted at the New York State Station by S. A. Beach, and recently reported by U. P. Hedrick, are of special interest. These experiments were begun in 1893 on an orchard of 43-year-old apples on sloping upland with a medium heavy clay soil. They were completed in 1904.

> Throughout the experiments the orchard was given clean cultivation until about August 1, and was then seeded to a cover crop of oats, barley, or clover. * * * There were 94 trees in the test, representing the following varieties: Baldwin, Fall Pippin, Rhode Island Greening, Roxbury, and Northern Spy. The orchard was divided into 8 plats, 4 treated and 4 untreated. Wood ashes were applied to the treated plats at the rate of 100 pounds per tree, or 4,800 pounds per acre. During the last seven years of the experiment acid phosphate was applied at the rate of 8½ pounds per tree, or 408 pounds per acre. Calculations made from analyses of the fertilizers show that, on the average, 160 pounds per acre of actual potash were applied each year; 72 pounds of phosphoric acid from the ashes and 57 pounds from the acid phosphate; and lime at the rate of 32 pounds per tree, 1,536 pounds per acre. The amounts are in excess of the usual recommendations of these fertilizers for apples.

Yield and color of fruit were the two standards used for measuring the effects of the fertilizer. As for the increase in yield, it is reported that the results were practically negative from a financial standpoint.

With regard to color it is stated that—

> Taken as a whole, the results are disappointing. They lack uniformity and were not decided enough in a sufficient number of the twelve seasons to enable us to state that the addition of the substances applied heightened the color of

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[a] Compiled from New York State Sta. Bul. 289. See also U. S. Dept. Agr., Office Expt. Stas. Rpt. 1903, p. 537.

apples under the conditions of this experiment. The effects varied not only from season to season, but varieties varied greatly in some seasons, and in others the same variety would color differently in plats receiving the same treatment. When we consider the number of factors which are known to influence color in fruit we can not assume with any degree of certainty that the results set forth above show that the addition of these fertilizers changed the color of the fruit in this experiment in any season. Thus, exposure to light; the intensity of the light; amount of foliage on the tree; the healthfulness of the foliage; the amount of stored food in the plant; soil heat; the texture of the soil—all of these, besides potash and phosphoric acid, have an influence. The relations of these factors are so intricate that it is almost impossible to separate them in an experiment like this, and especially as the differences were so slight.

A comparison of the color data with meteorological data for the twelve-year period shows that the treatment seemed to have an influence in coloring fruit only in those years when the apple did not develop well, as in 1893 and 1902: and that in other seasons, as in 1896, 1900, 1904, when climatic conditions were favorable to the development of fruit and foliage, the coloring was as nearly perfect on the untreated as on the treated plats.

It is not to be inferred from the results of this experiment that commercial fertilizers are never needed in the apple orchard, but they do appear to show that—

An orchard soil may not need potash, phosphoric acid, nor lime, even though the soil may have been cropped a half century; that in a soil which produces apples of poor color, potash and phosphoric acid may not improve the color: and that the apple does not seem to be as exhaustive of soil fertility as farm crops. The experiment suggests, as well, that to assume without definite knowledge that a tree needs this or that plant food, often leads to the waste of fertilizing material; and that in the matter of fertilizing an orchard a fruit grower should experiment for himself, since an orchard's need of fertilizer can be determined only by the behavior of the trees when supplied with the several plant foods.

RINGING HERBACEOUS PLANTS.[a]

U. P. Hedrick, O. M. Taylor, and R. Wellington recently reported from the New York State Station the results of an experiment in the ringing, or girdling, of tomatoes and chrysanthemums. This is practically a new field of investigation. The first work to be noted along this line was that of L. Daniel, a French investigator,[b] who conducted the experiment with different species of crucifers, eggplants, and tomatoes. With cabbage and Brussels sprouts the operation resulted in a more open head combined with a decrease in size. With these plants. as well as with kohl-rabi and ruta-bagas, ringing appeared not only to have no practical value, but was also detrimental to their best development. With eggplant, however, the size of the fruit was nearly doubled by ringing and was also considerably increased with tomatoes, although the flavor of the fruit was unfavorably influenced. In 1901, U. P. Hedrick, in writing of an experiment conducted by one of his students in the ringing of chrysanthemums, said " that all competent judges who looked over the experiment agreed that there was an increase in size, and that the blossoms were hastened in their development.

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[a] Compiled from New York State Sta. Bul. 288.

[b] Compt. Rend. Acad. Sci. [Paris], 131 (1900), p. 1253. See also Amer. Gard., 22 (1901), No. 328, p. 245.

These results were not considered conclusive, however, and were offered principally with the view of creating a greater interest along this line.

Ringing has been employed to some extent with woody fruit-bearing plants, such as the apple, the grape, and the currant, as well as with other tree fruits to a lesser degree for some time past. The outcome has been by no means uniform, and growers are usually advised to submit the practice to experiment under conditions common to their own soil, climate, etc., before making free use of it.

On the other hand, under favorable conditions, ringing has appeared " to cause unproductive plants to set fruit, to increase the size of the fruits and thereby the productiveness of the plant, and to hasten the maturity of the fruit." Work with grapes and apples along this line, in which the results appeared to be favorable, was reported by the Massachusetts Hatch Station.[b] The New York State Station also reported favorable results in some instances with grapes.[c]

With regard to the recent New York State Station experiment with tomatoes and chrysanthemums, the authors state that " if ringing would bring herbaceous plants into fruiting, increase the productiveness, and hasten the maturity of the product, as with grapes and apples, the operation would be of especial value in growing some greenhouse plants, since the qualities mentioned are essential to success in growing commercial crops under glass. It would commend itself, too, because the devitalization which eventually follows the ringing of plants would be of little consequence with most of those grown in the greenhouse, since they are grown for but one or two seasons and then discarded." Both the tomatoes and chrysanthemums were grown in the greenhouse under normal successful conditions. Several plants of the Lorillard tomato were ringed in the winter of 1905–6. The plants were trained to a single stem. " The members of one group of plants were ringed as soon as the second cluster of fruits had set; those of the second group when the fourth cluster had set. Plants in a third group were unringed. Ringing consisted of removing a five-eighths inch strip of bark, cutting through the woody tissue."

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[a] Amer. Florist, 17 (1901), p. 729.

[b] Massachusetts Sta. Bul. 1.

[c] New York State Sta. Bul. 151. See also U. S. Dept. Agr., Farmers' Bul. 105.

Several varieties of chrysanthemums were treated in practically the same manner in the autumn of 1906. The first group was ringed just as the buds appeared, the second about two weeks later, when the buds were one-third grown.

The results of the ringing as noted in various ways were disappointing. With the tomatoes the time of maturity was unaffected, the average number of fruits was reduced 18 per cent by the first ringing and 10 per cent by the second ringing, and the effect on the weight of the fruit was variable and inconsequent. Neither the color nor the flavor appeared to be altered by ringing. The foliage of the plant was somewhat more rank, although the root system apparently suffered from starvation. With the chrysanthemums the principal results noted were that "the first ringing hindered the opening of the buds in all of the varieties except one; the second ringing slightly hastened the maturity of all except one. The size of the blossoms of all the varieties was reduced and the earlier the ringing the greater the injury."

As a general result of this work the authors are of the opinion that it is very doubtful whether ringing can be made beneficial to herbaceous plants, in view of the fact that the loss to the plant is great and there seems to be little or no compensating gain.

"The deleterious effects of ringing on herbaceous plants are so marked that the query arises as to whether woody plants do not suffer in similar degree and the operation possibly cause a greater loss to the plant than is gained in the product."

POTATO SCAB.[a]

Potato scab is a well-known and widespread disease which does an immense amount of damage to the potato crop annually. Injury and consequent losses due to scab remain very large in spite of the fact that the cause and efficient methods of controlling the disease have been known for many years. The minute parasitic organism which causes the disease was discovered and described by Roland Thaxter of the Connecticut State Station in 1890, and several other stations have contributed to the working out of efficient methods of treatment of the disease. The roughened, scabby, pitted surface of potato tubers due to scab is well known practically everywhere that potatoes are grown, and the use of untreated seed and the too common practice of reserving unsalable, scabby tubers for planting has resulted in an increase rather than in a decrease of the disease in many localities.

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[a] Compiled from Maine Sta. Bul. 141.

In a bulletin of the Maine Station, W. J. Morse summarizes the more important practical facts regarding the disease as follows:

Crop infection on old land may come from the soil, from the seed, or from both. On new land the source is largely from undisinfected seed. Soil conditions, the application of lime, ashes, chip dirt, etc., may favor the development of scab, but are incapable of causing it.

Alkaline soils, the use of stable manure, lime, ashes, and certain chemicals of alkaline nature favor the fungus. Acid soils and certain other chemicals are unfavorable to it.

Beets and the roots of a few other vegetables are attacked by the disease, but the fungus may persist in infected soil for several years without the presence of known host plants.

Badly infested soils should be devoted to such crops as grains, grasses, and clovers, for as long a time as possible. Fertilizers favorable to scab should be avoided and " souring " the soil by green manuring is recommended.

On clean soils, only healthy, disinfected seed tubers should be used. Manure containing uncooked scabby potatoes or refuse should be avoided, but no other precautions as to fertilizers are necessary. Clean soil may be infected by means of tools, bags, baskets, etc., which have been in contact with infected land or tubers.

Small amounts of seed are best disinfected by soaking: (*a*) Two hours in solution of one-half pint formalin to 15 gallons water, or (*b*) one and one-half hours in 2 ounces of corrosive sublimate dissolved in 15 gallons of water.

For large quantities of seed, formaldehyde gas, generated by the use of potassium permanganate, is the most practical disinfecting agent. Place seed tubers in bushel crates or shallow, slat-work bins in a tight room. For each 1,000 cubic feet of space spread 23 ounces of potassium permanganate evenly over the bottom of a large pan or pail in center of room. Pour over this 3 pints of formalin, leave room at once and allow to remain tightly closed for twenty-four to forty-eight hours.

The corrosive sublimate (a deadly poison), formaldehyde (usually sold under the name of formalin, a 40-per cent solution of formaldehyde), and the potassium permanganate can be obtained of any druggist. Corrosive sublimate costs about 15 cents per ounce, formalin, which should contain not less than 35 per cent of formaldehyde, .40 to 50 cents per pint, potassium permanganate 30 cents per pound.

Treatment is therefore neither very expensive nor difficult to apply according to the above directions. It would seem good economy to incur the small expense involved in protecting the potato crop from possible serious injury by scab and clean soils from infection by diseased seed.

EFFECTS OF ESCAPING ILLUMINATING GAS ON TREES.[a]

In a report of the Massachusetts Station, G. E. Stone calls attention to the increasing damage to shade and ornamental trees due to escaping illuminating gas.

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[a] Compiled from Massachusetts Sta. Rpt. 1906, p. 180.

The increased death rate from this cause may be accounted for by the fact that gas is now more extensively used than formerly, and the larger pipes now in use, together with modifications in the methods of laying these pipes and calking, may be in part responsible for the increased leakage. At any rate, it would seem that where small pipes have been in the ground for many years with thread-joint connections there is much less leakage than where larger pipes are used, and where the calking is done with Portland or Roman cement and oakum or lead.

Even small leaks of only 2 to 3 cubic feet per day are capable of injuring trees in course of time, since the soil eventually becomes charged with gas. " Should the roots of trees happen to be near these leaks, the trees will become unhealthy, but perhaps will not die. There are hundreds of city trees affected in this manner, and gas is seldom suspected of causing their sickly condition."

There are two classes of injury which may readily be distinguished as resulting from gas poisoning: First, incipient cases; and, second, pronounced cases. In the first series we have those already alluded to as resulting from small leaks, and the ground in such cases never becomes fully charged for any considerable distance. They may not result in killing the tree directly, but cause it to be unhealthy, and there is likely to be a large amount of dead wood found on such trees annually. Occasionally a large tree may be located near a small leakage, and in such a case only a single root will be affected. Those portions of the trunk of the tree in direct connection with the leak will, however, show the effects of gas poisoning. Small leaks of this description often produce only local injury. Trees affected in this manner may suffer what is termed "general debility." * * * In severe cases of gas poisoning, such as take place where there is a large leak, the effects on a tree are very pronounced, and there is absolutely no hope of recovery for a tree which has once been severely injured by gas; in short, where a tree has been defoliated, or even half defoliated, from the effects of gas, there is no hope for it, although it might be possible, if one could dig up all the soil around it and expose it to the air, to eliminate much of the gas in the soil, in which case the tree might make some attempt to recover.

The characteristic symptoms of gas poisoning are quite marked to one familiar with them, and can generally be distinguished from other kinds of injury which are likely to affect a tree. It requires, however, pretty close observation and thorough understanding of conditions in order to distinguish gas poisoning from some other types of injury which may occur. * * *

In general, however, the symptoms shown by trees affected with illuminating gas are quite different from those arising from other causes which are likely to be active. Trees affected with gas are very susceptible to rapid disintegration. One of the first effects of poisoning in summer would be a yellowing and drying up of the foliage, and a greater or less defoliation of the tree, according to the degree of poisoning. The trunk of the tree is generally dark colored, indicating an absence of life; but this feature is not always present.

The occurrence of various species of fungi on trees affected by gas is rather conspicuous, since these fungi are often very numerous, and make their appearance soon after a tree has been injured; whereas on trees dying from other causes it is sometimes many years before the bark becomes covered with fungi. The sap-wood is often found to be discolored, and it has peculiar, characteristic odors which assist in a diagnosis. Sometimes, however, especially when the

> tree is injured by gas in late summer, at which time the flow of sap is not so pronounced as in the spring, the odors of the wood are not so marked. * * *
>
> There is considerable difference in the resistance of soils to gas. In gravelly soils we have known gas to travel 2,000 feet without any difficulty when the ground is frozen, and escape into the cellar of a house; whereas in heavier soils gas is more likely to be restricted to smaller areas.

Digging up and thoroughly airing the soil will generally overcome poisonous properties resulting from escape of gas, but where the escape has been long continued and the soil has become thoroughly charged with the poisonous compounds in gas the sweetening process is slow, and it will be some time before trees can be replanted on the soil with good show of success.

THE TUNA OR PRICKLY PEAR AS A FOOD FOR MAN.[a]

The prickly pear, Indian fig, Barbary fig, or tuna, for these and other names are applied to the fruit of varieties of Opuntia, a family of cacti, is eaten in large quantities in the warm countries where it grows, and is of some commercial importance outside its native region. In many of the northern fruit markets in the United States these fruits are fairly common in the late fall, the present supply coming almost exclusively from southern Europe. Tunas are common in the southwestern United States and are used as food to a considerable extent, but they are much more abundant and used to a much greater degree in Mexico. (Fig. 1.)

Recently published bulletins of the New Mexico Station and the Bureau of Plant Industry of this Department, by R. F. Hare and D. Griffiths, report an extended experimental study of the tuna and its uses as food, and discuss also the cultivation, harvesting, marketing, and storing of these fruits and related questions.

There are many varieties of Opuntias, including both wild and cultivated sorts, which yield edible fruits to which the name tuna is applied. The fruits vary in shape and color according to the species and the conditions under which they are grown. They are commonly from 1 to 3 inches in diameter and are usually pear-shaped or fig-shaped, though in some species they are nearly spherical, and weigh from an ounce to a half pound or more, and when ripe vary from a yellowish green to a dark purple color. All varieties have minute spicules arranged in bunches over their surface, about one bunch to every square inch in the better varieties, though in most species the spicules are more numerous. The fruits of most species have large spines also which correspond to those on the cactus plant, but they are much more delicate and usually fall off before the fruits are thoroughly ripe. A cross section shows that the fruit is covered with a thin skin or epidermis, beneath which there is a rind varying in thickness from one-eighth to one-half inch. Inside this is pulp or edible portion, in which are found embedded from 100 to 200 or more seeds, for, with a few exceptions, these fruits are characterized by a very large seed content.

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[a] Compiled from New Mexico Sta. Bul. 64; U. S. Dept. Agr., Bureau of Plant Industry Bul. 116.

The extended series of analyses of Mexican and New Mexican tunas reported by Hare and Griffiths show that they resemble other succulent fruits in composition, the solid material constituting some 6 to 13 per cent of the total edible portion. The principal nutritive materials are sugars, 7 or 8 per cent being perhaps a fair average value. Small amounts of nitrogenous material, fruit acids, and ash are also present.

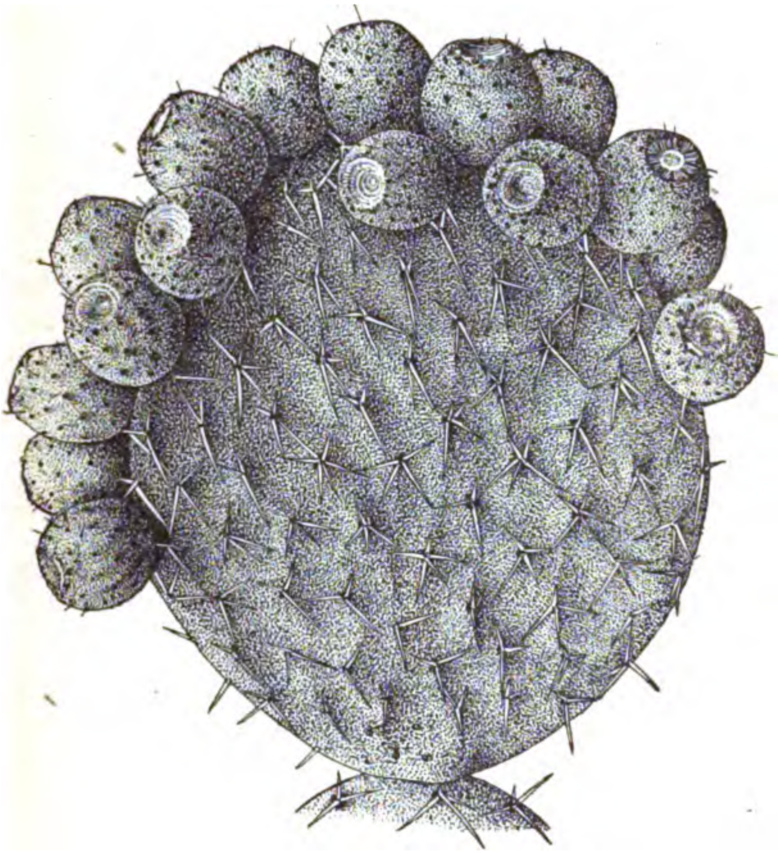

FIG. 1.—Tuna cardona, the most highly prized of all the Mexican tunas.

FRESH TUNAS.

In Mexico, where many varieties are eaten, some are considered more wholesome as well as more palatable than others. The harvesting of wild and cultivated tunas is a matter of much importance, and the methods which are followed in Mexico are described at length by Hare and Griffiths:

> During the height of the season, when the fruit is cheapest, women appear on the markets each morning with huge baskets of them ready peeled. * * * Each purchaser is furnished with a tip of maguey leaf or a thorn of the mesquite with which to eat the pulps. * * * By far the greater amount of fruit is sold unpeeled. This is especially true during the season when fruits are not abundant, for less waste attends it. Sometimes the purchaser peels the fruit himself and at others he eats it as the vender or his attendant peels it for him. The process of peeling is simple, * * * the knife being run across the top and down one side to the base, when the pulp may be picked out easily. When fully ripe much of the rind of some species is consumed with the pulp. * * *
>
> On the whole it may be said that tunas are easily injured and consequently much care is necessary in handling them when they are intended for packing. They must also be well aerated in storage, which is true of all fruits. * * * Contrary to popular opinion, some tunas can be preserved in the fresh condition about as long as the common fruits of the temperate zone, if properly handled.

DRIED TUNAS AND TUNA PRODUCTS.

Tunas are dried in large quantities, the thin skin which covers the rind being first removed. White or yellow varieties are usually selected for drying, as they yield a more attractive product than the red. A number of other food products are also prepared from tunas, notably a thick sirup known as "Miel de Tuna," or tuna honey, a thick, paste-like mass known as "Melcocha," and a more solid paste known as "Queso de Tuna," or tuna cheese, which in appearance somewhat resembles old-fashioned apple marmalade. A fermented drink called "Colonche" is also made from these fruits.

In making the tuna honey "the peeled tunas are put in the kettles and boiled until the free seeds fall to the bottom: This occupies usually about two hours, fresh material being added from time to time as the water evaporates. The seeds are removed with a sieve and the sirup returned to the fire and boiled slowly for two or three hours more, or until it approaches the consistency of honey. It is then poured into wooden troughs, where it is thoroughly mixed with wooden paddles until completely cooled. After setting for twelve to twenty-four hours it is packed away in bottles or earthenware jugs. It may be kept about the same as molasses, and is said to remain in good condition indefinitely. After a time, however, it candies and becomes difficult to handle."

Melcocha and tuna cheese are made from peeled tunas from which the seeds have been removed, a seeder being used for the purpose.

The most palatable prickly pear growing in New Mexico, according to the authors quoted, is a variety with dark-purple fruit and a brilliant red juice, and while it is not eaten very extensively fresh it is used by the Mexican residents in considerable quantity in the manufacture of preserves. In studies which were made with a view to determine the best use of the brilliant-colored juice the pulp was evaporated to a thin paste constituting about one-eighth of its original volume without suffering any change in color.

This paste was used for coloring apple jelly and candy, and was found to serve admirably for the former purpose. Because of the danger or prejudice against the use of the coal-tar dyes, it may have some value commercially as a vegetable coloring matter. Candy colored by means of it lacked the brilliancy of that colored with coal-tar dyes, and it is doubtful if it could ever be very generally used for this purpose. The paste prepared in this manner had 51.6 per cent sugar, only 0.48 per cent being sucrose. By removing the sugar and insoluble solids from the material the coloring matter could probably have been concentrated to as rich a color as cochineal paste. * * * As to whether or not the fruits will ever prove of commercial value for the preparation of a coloring matter will, we believe, depend solely upon the yield per acre that can be obtained. This can only be determined by experiment.

As regards the value of tunas in general and the possibilities of their cultivation, Hare and Griffiths believe that conservative judgment based on observation and experiment "would pronounce many species of prickly pear to be decidedly susceptible to cultivation and highly productive of both fruit and forage under proper conditions of temperature and moisture."

It is also true that there are species which thrive under moderate extremes of heat; that, as a rule, they are adapted to conditions of periodical rainfall and thrive where the distribution of moisture is too irregular and uncertain for commonly cultivated crops; that the spines and spicules have been practically successfully eliminated from the plant body in valuable species but not from the fruit; that all of the so-called spineless forms concerning which we have definite knowledge are less hardy, especially toward drought conditions, than spiny natives; that it is quite probable that by persistent breeding and selection the spines and spicules may be more completely removed and the plant bred to withstand a greater degree of cold; that the plants can be fed together with more concentrated foods with profit; that the fruit is now, in its spiny condition, an important and highly prized ingredient in the diet of the poorer classes of Mexico and Sicily especially; and that highly prized products are prepared from the fruits; that the group is of sufficient economic promise to merit thorough investigation.

COOKING CEREAL FOODS.[a]

Cereal breakfast foods may be roughly divided into three groups: (1) Those like old-fashioned oatmeal which are not cooked at all in the process of manufacture, (2) those like flaked or rolled grains which are partially cooked at the factory, and (3) those which have been submitted to some special cooking processes, like browning or baking, and may be eaten without additional cooking. Sometimes the cooked or partially cooked foods are treated with malt, which, it is claimed, converts some of the carbohydrates into soluble forms.

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[a] Compiled from Connecticut Storrs Sta. Rpt. 1904, p. 180; Maine Sta. Bul. 118; Ann. Rpt. Ontario Agr. Col. and Expt. Farm, 32 (1906), p. 63; Jour. Soc. Chem. Indus., 26 (1907), p. 240.

Extended series of digestion experiments with cereal breakfast foods have been reported from the Connecticut, Maine, and Minnesota experiment stations and the Ontario Agricultural College, which warrant the general conclusion that these foods closely resemble different types of bread in digestibility as they do in composition, the breakfast foods from which the coarser part of the grain has been removed approximating white bread in thoroughness of digestion, while those sorts which retain the branny portions more closely resemble graham bread and whole-wheat bread.

The subject of composition and digestibility of these foods and related questions has been discussed in earlier Farmers' Bulletins.[a] It is generally believed that long-continued cooking renders cereal breakfast foods more easily and thoroughly digested. In experiments carried on by R. Harcourt at the Ontario Agricultural College it was found that the farinas were broken down and rendered soluble to a greater extent by cooking than the oatmeals.

Young men in good health served as subjects of digestion experiments in which cereal foods cooked for a short period, twenty minutes, were compared with those cooked for a long period, eight hours. "In order that the results might be strictly comparable, the same subjects were used in determining the digestibility of the meal cooked for the short and long periods. Different subjects, however, were used with each sample of meal. This was done to bring in as many conditions as possible." The average results of the experiments follow.

Average digestibility of rolled oats and wheat farina cooked for long and short periods.

Kind of food.	Organic matter.	Protein.	Fat.	Carbohydrates.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Rolled oats (cooked twenty minutes)	94.2	81.5	92.5	98.0
Rolled oats (cooked eight hours)	95.4	84.3	94.6	98.3
Wheat farina (cooked twenty minutes)	95.5	79.3	94.9	98.2
Wheat farina (cooked eight hours)	95.3	79.4	95.6	98.5

From the above results, it is evident that the length of time the meal was cooked did not very materially influence the percentage amount digested. It is, of course, possible that less energy may have been expended in digesting that which was cooked the longer time, but no figures could be procured on this point. It is, however, important that starchy foods be cooked sufficiently long to cause the rupture of the starch cells. Judging by results, this apparently was accomplished, at least, nearly as well in one case as in the other.

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[a] U. S. Dept. Agr., Farmers' Buls. 237, p. 14; 249.

From all the data which are reported regarding composition, digestibility, and comparative cost of a number of kinds of cereal breakfast foods Professor Harcourt concludes that—

> It is evident that corn meal, rolled oats, and the farinas, especially if bought in bulk, are the most economical breakfast foods. It is, however, true that these foods do not agree with everyone and that the so-called predigested foods may be useful for those people who have difficulty in digesting starch. They may also have a place in a hurry-up breakfast, but it is evident that a curious name given to a much-advertised food does not indicate a high nutritive value, and the intelligent buyer who has to consider economy will hardly pass by the old forms of breakfast foods unless his own experience has actually demonstrated that these newer foods have a superior value.

SOME EXPERIMENTS IN SILAGE MAKING.[a]

The fermentation of silage entails more or less loss of material, but is commonly considered beneficial, as it develops flavors and softens plant tissue.

LOSSES IN THE SILO.[b]

The amount of material lost when green crops ferment in the silo has been frequently studied. In recent tests carried on at the Canada experimental farms with an experimental silo it was found that corn lost 15 per cent of its gross weight, a mixture of corn and rape 33 per cent, and rape alone 54 per cent. The material was placed in the silo in September and taken out in March.

STEAMED SILAGE.

Excessive fermentation produces silage with a high acid content, in addition to causing a large loss of nutritive material. The effect of checking extensive fermentation by treating silage with steam has been studied by A. L. Knisely at the Oregon Station for a number of years. The silos were filled in the usual way and steam generated in a boiler was passed through a pipe into the mass until it was thoroughly heated (twelve to fourteen hours at 20–40 pounds pressure) in case of silos 5 feet in diameter and 12 feet deep. Large as well as small silos were used. The method of piping to introduce the steam at the bottom and in the middle of the silos is shown in figure 2. The sugar, acidity, and moisture were determined in the fresh material and at frequent intervals when the silage was removed from the silo. In the case of cut vetch and whole and cut clover the acid in the fresh material before ensiling ranged from 0.18 to 0.27 per cent, calculated as acetic acid, and in the steamed silage when taken from the silo from 0.42 to 0.88 per cent. The sugar in the fresh material ranged from 1.36 per cent to 2.07 per cent and in the silage from 0.93 to 2.08 per cent. In a test in which the silage was not steamed the fresh clover contained 0.18 per cent acid and the ensiled material 1.01 per cent, the proportions of sugar in the fresh and ensiled material being 1.82 per cent and 0.75 per cent. Another sample of ensiled clover, which was not steamed, contained 1.16 per cent acid. In later experiments the acidity of unsteamed silage of all kinds (corn, vetch, and clover) varied from 1.01 to 1.94 per cent, averaging 1.58, of steamed silage from 0.3 to 0.88 per cent, averaging 0.53 per cent. Steaming seems to be more effective in checking the acid fermentation in corn than in other crops.

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[a] Compiled from Delaware Sta. Rpt. 1903, p. 36; Oregon Sta. Bul. 72, Rpts. 1903, p. 34; 1905, p. 53; Canada Expt. Farms Rpts. 1904, p. 166.

[b] See also U. S. Dept. Agr., Farmers' Bul. 133, p. 31.

In one of the tests of steamed silage immature corn fodder which had been touched by frost was used. Full analyses of the fresh and ensiled material are reported, the acid in the silage being determined at intervals of a week for about two months. The fresh material contained 0.18 per cent acid and 2.43 per cent sugar and the material when taken from the silo 0.48 per cent acid and 2.15 per cent sugar. For purposes of comparison a full analysis was made of ordinary corn silage. This contained 1.65 per cent acid and 0.49 per cent sugar. A comparison of the two materials led the author to conclude that the ordinary silage "underwent considerably more chemical or biological changes than did the steamed silage, these changes being indicated by the large increase in acidity and decrease in sugar." The steamed corn silage was fed to stock and was found to have suffered very little injury from the frost.

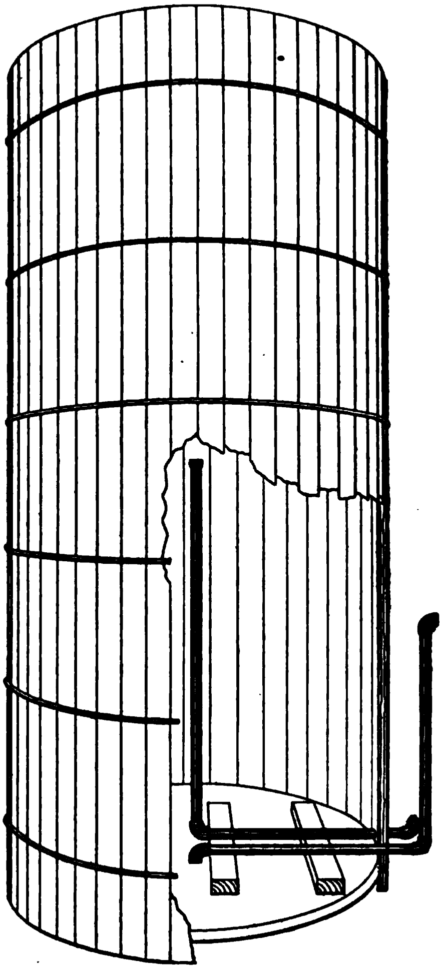

FIG. 2.—Method of piping for steaming silage.

As regards steaming silage in general, the author considers that the " operation was quite beneficial and the steamed silage was much better than that which was not steamed. Stall-fed animals were able to eat without the least injury 50 to 75 pounds of this steamed silage per day."

SILAGE FROM CURED CORN FODDER.

At the Delaware Experiment Station A. T. Neale has studied the possibility of making silage from cured corn fodder, being led to undertake the work by the fact that formerly good results were obtained locally by feeding cut corn fodder which was packed into boxes, moistened with hot water, and allowed to stand for twenty-four hours. Concentrated feeds, such as cotton-seed meal, could be mixed with the mass and such a mixture used in the place of bran. The method is too inconvenient for general use, but it suggested the possibility of making silage from dried corn fodder by the addition of water and subsequent fermentation. When the experiment was tried, a rise of temperature was noted in the silo and the development of an aromatic odor, as in the case of green silage. It was found that young and old stock ate such silage practically without waste and that cows preferred it to dried shredded fodder.

> It is a better and a safer mass to use with cotton-seed meal than dried fodder or hay. The meal adheres to the damp fodder, can not be separated from it by the stock, mastication is insured, and impaction of cotton-seed meal prevented. * * *
>
> In this experiment the quality of the fermented product varied. Where the moisture content was normal, the aromatic odor above noted was present. No points of excessive moisture were found. Fodder in the bottom of the silo was not as moist as that nearer the top. In places channels had formed, through which the water, pumped upon the surface, had flowed, leaving masses of only partially moistened fodder, in which to a limited extent a musty smell and visible mold in extreme cases were noted. This was also the case in the product stored in immediate contact with the cemented lining of the silo, a condition also likely to exist in silage made from green cornstalks.
>
> The fact that the fire risks were noticeably decreased by moistening the fodder corn was patent to all observers.

In connection with the Delaware work the loss of material from fermentation was calculated in making silage from dried corn fodder moistened with water. According to the data reported, " 100 pounds of the fodder would lose 2.81 pounds of starch, or its equivalent, to produce through its complete fermentation the necessary heat to raise the temperature of the mass to 165° F., and this amount, 2.81 pounds, is just 6 per cent of the total dry matter of the fodder."

RECENT HORSE-FEEDING TESTS.[a]

Various problems concerned with horse feeding and management have been studied at the agricultural experiment stations, and such work has been summarized in earlier Farmers' Bulletins.[b]

OATS.

Of recent work, that reported by F. W. Taylor, of the New Hampshire Station, is of interest, as it has to do with the comparative value of light and heavy oats for draft animals. Three pairs of work horses of Percheron blood were used in the test, one in each lot being fed heavy oats for thirty days and the others light oats. During an additional period of thirty days the conditions were reversed. In every case 16 pounds of the oats—that is, 5 pounds in the morning, 5 pounds at noon, and 6 pounds at night—were fed with mixed hay of average quality ad libitum. All the horses were used for farm work, requiring average exertion and endurance. As shown by weighings taken twice a week, 1 horse lost on both light and heavy oats, 5 gained on heavy oats, and 4 gained on light oats.

> The total gain or loss in any case was not material and was not much greater than the variation in weight from one day to another. The practical results of this experiment seem to indicate that, pound for pound, the light oats have nearly the same feeding value as the heavy oats. Although the heavy oats contain a higher percentage of protein, fat, and nitrogen-free extract and a less percentage of fiber than the light oats, it seems probable that the relative proportions of these constituents in the two grades are such that they are more easily and thoroughly digested. * * * The percentage of kernel, as would be expected, bears a close relation to the weight per bushel. It should be remembered that although the two grades are practically equal pound for pound they are not equal quart for quart, and that in feeding by measure, as is usually done, due allowance should be made for the heavy oats and a less quantity given. Since oats are bought and sold by weight instead of measure, there seems to be no gain made in buying the heavy oats at a much advanced price over the light oats.

The French investigator, Grandeau, states, on the basis of experiment and observation, that crushing oats increases their digestibility, and that crushed oats have been fed with satisfactory results for some years by a cab company in Paris and have effected a decided saving.

MOLASSES.

The possibility of substituting for oats a mixed feed made up of 60 per cent molasses, 20 per cent corn feed, and 20 per cent linseed meal was studied by H. van de Venne with army horses at Brussels.

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[a] Compiled from Louisiana Sta. Bul. 86; New Hampshire Sta. Bul. 120; Utah Sta. Bul. 101; Breeders' Gaz., 48 (1905), p. 697; Centbl. Agr. Chem., 34 (1905), No. 12, p. 825; 2 Cong. Internat. Aliment. Ration. Bétail, 1905, Rapps., p. 1; Jour. Agr. Prat., n. ser., 10 (1905), p. 777; Natal. Agr. Jour. and Min. Rec., 9 (1906), p. 1123; Soc. Aliment. Ration. Bétail, Compt. Rend., 10. Cong., 1906, p. 87.

[b] U. S. Dept. Agr., Farmers' Buls. 103, 133, 170, 222.

Belgium. Judging by the weight of the animals, he concluded that the normal ration made up of 12.13 pounds oats, 1.32 pounds bran, 6.61 pounds hay, and 4.41 pounds chopped straw was sufficient for their needs. When about half the oats was replaced with the molasses feed somewhat greater gains were made than on the normal ration. The molasses ration had no marked effect on the amount of water consumed.

Molasses was an important constituent of the above-mentioned ration, and this material is attracting considerable attention at the present time as a feeding stuff for horses and other farm animals.

According to W. H. Dalrymple, of the Louisiana Experiment Station, who has studied the question in the Louisiana sugar plantations, " the custom of feeding molasses to the work stock on our large sugar estates has been adopted in anything like systematic manner only within the past few years. Previously, and when the price was extremely low, quantities of the material were run into large iron troughs, and the mules allowed free access to it; and, to some extent, this rather prodigal method still prevails. The true value of blackstrap as a food stuff has become more apparent of late years, however, and as the question of feeding economically has become one of considerable moment to our planters, it is being used more as an ingredient of the 'balanced ration,' and, as a rule, mixed with other concentrates."

The average consumption on 47 plantations in the sugar belt was found to be about 10 pounds per head per day, and the range, according to the statistics gathered, about 2 to 21 pounds. A gallon of blackstrap molasses weighs on an average 12 pounds. Chopped hay, pea vines, alfalfa, and occasionally green cane tops, and some concentrated feed are commonly mixed with the molasses and the whole fed in three portions. It is desirable to begin with small amounts of molasses when this material is introduced into a ration.

The data collected are in accord with the generally accepted view that molasses, where it is available at reasonable prices for feeding purposes, constitutes a wholesome and easily digested, as well as an economical, constituent of a ration for draft animals. " It would seem that the somewhat general impression that molasses, from any source, is unduly laxative, must have been based upon the effect produced by the by-product from the beet factory, and not sugar-cane molasses, as there is abundant evidence in our own State of the harmless effect of blackstrap, so far as a purgative action is concerned."

Molasses, as everyone knows, owes its nutritive value largely to the sugar which it contains. A French investigator, who studied the feeding value of beet molasses, states that experimental evidence shows that sugar did not appreciably diminish the digestibility of the nutrients of a ration when the amount fed to horses was equal to 5 or 6 pounds per 1,000 pounds live weight. Sirup and molasses, however, when fed in smaller quantities decreased the digestibility of the ration, a fact which is explained by the laxative properties of the alkaline salts in beet molasses. The general conclusion drawn from the experimental evidence summarized by this investigator, however, was that beet molasses is a wholesome and hygienic feed when the amount consumed per day does not exceed 6 or 8 pounds per horse.

SUCCULENT FEEDS.

A number of investigators have recently studied succulent feeds for horses. R. W. Clark, of the Utah Station, states that 16 to 20 pounds of well-fermented, solid sugar-beet pulp was fed to horses experimentally for six or eight weeks and no irregularity in the health of the animals was noted which could be attributed to the pulp.

In a test covering two periods of twenty-eight days each, made with 4 work horses, alfalfa, oats, and sugar-beet pulp were fed in comparison with a ration without pulp. Little difference was noted in the effect of the two rations, the horses on pulp losing on an average 6 pounds and those without pulp 2 pounds per head. "The above results indicate that beet pulp can be fed to horses without detriment to their health, though the amount consumed (9 pounds per head daily on an average) was small. The horses on pulp received 1.5 pounds less of grain per day than those that received no pulp, the amount of hay fed being the same in each case. The animals in each lot did equally well, and whether or not 9 pounds pulp is equal to 1.5 pounds oats when fed as in this experiment, awaits further demonstration."

It is stated that for several years colts have been allowed access to sugar-beet pulp at the factory where the test was made, and in no instance, so far as can be learned, has any trouble arisen from feeding it.

Jerusalem artichoke tubers have at various times attracted considerable attention in the United States as a feeding stuff for farm animals.[a] Having noted that the peasants in southern France are in the habit of feeding Jerusalem artichoke tubers to work horses, a French investigator recently studied the value of this material with draft animals and obtained satisfactory results. In his opinion, not over 13 quarts should be fed. The artichokes, it is stated, should be mixed with crushed grain and 11 to 16 quarts of chopped hay, which will absorb the moisture. When artichokes were thus substituted for barley or oats for one hundred days no unfavorable results were noted.

In Natal corn silage has been tested with satisfactory results for army horses. The daily ration of horses running in paddocks consisted of 4 pounds of chopped corn silage, 2 pounds of alfalfa or forage, a few pounds of crushed corn, and an ounce of salt. "From the first they liked the ensilage, and did remarkably well on it. Many horses not doing well before showed improvement. The droppings were of a particularly healthy nature. The stabled horses also had a few pounds mixed with other food—even those working—at their midday feed, and did well on it."

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[a] U. S. Dept. Agr., Farmers' Bul. 73, p. 92.

ALFALFA.

A recent publication of the Bureau of Animal Industry, by I. D. Graham, on the uses of alfalfa for farm animals, summarizes data on the value of this feeding stuff for horses as follows:

> Horses and mules "thrive on alfalfa pasture. * * * While * * * alfalfa is too rich a food for mature horses unless used in combination with some other roughness, it is an excellent feed for young horses, as it seems to contain just the elements necessary to develop bone, muscle, and consequent size. Caution should be used, however, in feeding alfalfa to horses, particularly if they have not been accustomed to it. Like other concentrated feeds, it seems to stimulate all the physical processes to such an extent that various disorders of the digestive system may appear. This is particularly noticeable in the urinary and perspiratory glands. * * *"
>
> When alfalfa is fed to horses in considerable quantity the grain ration must be proportionately reduced and an abundance of other roughness furnished. When horses have attained a mature age and it is desirable to change from other hay to alfalfa, this change must be very gradual, and the alfalfa selected for this purpose should be more advanced in growth at the time of cutting than that which is to be fed to cattle or sheep. As a general statement, very ripe alfalfa hay is the best to use for work horses and driving horses, while that prepared in the usual way—that is, cut when the field is about one-tenth in bloom—is better for the colts. In any event, horses that are fed alfalfa hay must be given abundant exercise.

SUPPLEMENTS TO CORN IN HOG FEEDING.[a]

Corn must necessarily be used more freely than any other concentrated feed for hogs in the corn belt, as is pointed out in a recent bulletin of the Iowa Station, because if properly used it is especially well adapted to hog feeding and can usually be marketed as pork to the very best advantage. It is, however, becoming generally recognized that so far as health, thrift and rapidity of gain are concerned, corn alone, at least in dry lot feeding, does not give as satisfactory results, particularly with growing hogs, as corn combined with some other feed richer in protein. Wheat shorts is commonly considered the best supplementary feed for young hogs, but a number of other common feeding stuffs which contain large quantities of protein are on the market, and the experiments carried on at the Iowa Station were undertaken with a view to studying the merits of some of them. It is evident that if a small reduction per hog in the cost of feeding can be effected by the use of such feeds the aggregate gain will be very large.

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[a] Compiled from Iowa Sta. Bul. 91. See also Farmers' Buls. 169, p. 29; 276, p. 21.

Corn alone, and with varying proportions of ground barley, wheat shorts, meat meal, and tankage, was compared in the tests with hogs which are reported by W. J. Kennedy and E. T. Robbins. The relative merits of dry lot as compared with pasturage and timothy and clover pasturage were also studied, especially with reference to their importance in connection with the feeding of corn alone and with other feeds.

Four lots of 12 well-grown hogs each were used in the first test, comparing corn alone and supplementary feeds, and the gains made in 32 days on the several rations were as follows: Corn, 1.88 pounds; corn, barley, and shorts 2:1:1, 2.21 pounds; corn and meat meal 9:1, 2.68 pounds; and corn and tankage 9:1, 2.34 pounds.

When different amounts of meat meal supplementing corn meal were studied with 4 lots of 9 young pigs each, the average daily gain per head on the several rations was 1.16 pounds on corn meal alone, 1.75 pounds on corn meal and meat meal 7:1, 1.79 pounds on corn meal and meat meal 8:5:1, and 1.86 pounds on corn meal and meat meal 10:1.

The feed eaten per pound of gain in the above 2 tests ranged from 3.7 pounds with the mature hogs on corn and meat meal 9: 1 to 5.37 pounds with pigs on corn meal alone. The gain was most expensive with the latter lot, costing 3.97 cents per pound, and was least expensive with the mature hogs fed corn meal, barley and shorts, costing 3.15 cents.

A comparison of dry lot feeding and pasturage and of the effects of supplementing corn by other concentrated feeds under these conditions was studied with 10 lots containing 10 hogs each at the beginning of the trial, the test as a whole covering 112 days. When corn and shorts 2:1 and 1:1, corn meal and meat meal 5:1, and corn meal and tankage 5:1 were fed with timothy pasturage, the average daily gain ranged from 1.12 pounds on corn and shorts 2:1 to 1.37 pounds on corn and tankage 5:1. In the case of the same rations fed without pasturage the gain ranged from 0.81 pound on corn and shorts 2:1 to 1.09 pounds on corn and meat meal. On corn and timothy pasturage alone the average daily gain was 0.92 pound per hog and on corn and clover pasturage 1.19 pounds. Considering all the lots the concentrated feed eaten per pound of gain ranged from 3.98 pounds with the lot fed corn and shorts 1:1 on timothy pasturage to 5.12 pounds with the lot fed corn and shorts 2:1 in a dry yard, and was on an average 4.29 pounds. The cost of a pound of gain ranged from 3.35 cents with the lot pastured on clover and fed corn to 4.46 cents with the lot on corn and shorts 2:1 fed in a dry yard, and was on an average 3.92 cents.

In reporting these tests data are given regarding the shrinkage when slaughtering, and the profits are discussed at length on the basis of corn meal, meat meal, and tankage at different prices.

From a consideration of their results, the authors conclude that meat meal and tankage of similar composition are about equal pound for pound as supplements to corn in a ration for growing and fattening hogs and that both of these animal by-products are profitable adjuncts to corn and are more valuable for dry lot feeding than when pigs or hogs are being developed and fattened on pasture, especially if the pasture be composed of leguminous crops.

> Growing pigs fed meat meal or tankage to the extent of one-sixth of their ration, and older hogs having these feeds to the extent of 10 per cent of their ration, with corn, ate more feed and made more rapid gains than those fed on any other combination, such as shorts, barley and corn, or shorts and corn, tested in these experiments. In dry lot feeding a ration composed of corn with either meat meal or tankage produced from 25 to 40 per cent faster gains on quite mature hogs, and from 50 to 60 per cent faster gains on younger hogs, than a ration of corn alone, and in every instance the number of pounds of feed required per 100 pounds gain was decidedly less with the mixed ration.
>
> There was not very much difference in the results obtained when pigs of 137 pounds weight at the beginning of the experiment were fed corn with meat meal in the proportions of 7 to 1, 8.5 to 1, or 10 to 1. The proportion of 10 to 1 produced the most rapid gains and the greatest total profit, while the proportion of 7 to 1 required the least total amount of feed, but the greatest amount of meat meal, per 100 pounds gain. * * * Hogs fed on rations composed of corn and meat meal and corn and tankage were fully as acceptable to the buyers, both from the standpoint of the quality and condition of the flesh, as those fed on any of the other rations tested.

As regards the value of shorts as a supplement to corn, a ration of these 2 feeds 1:1 produced larger gains with less feed per pound of gain when fed to pigs on pasturage or in dry lots than a ration of corn and shorts 2:1.

"The advantage of the larger proportion of shorts was much more in evidence in the dry lot feeding than in pasture feeding. For feeding pigs on pasture with feeds at the prevailing prices a ration of corn alone produced 100 pounds of gain at a smaller cost than a ration of corn and shorts. The corn and shorts ration, however, yielded somewhat the greater total profit, due to the more rapid gains produced from the use of the same."

With respect to barley, the authors note "that a ration composed of corn 2 parts, barley 1 part, and shorts 1 part produced 100 pounds of gain at fully as low a cost as the rations containing meat meal or tankage in conjunction with corn. At the prevailing market price, barley proved to be an economical feed when combined with corn and shorts for finishing hogs for market."

When average results for pasturage and dry lot feeding were compared "there was less variation in the amount of concentrates required to produce 100 pounds of gain on pasture than in the dry lot feeding. With the pigs on timothy pasture, the most evident effect of increasing the amount of protein of the concentrated feed up to a point where the balanced ration was fed was to increase the amount of feed consumed and produce correspondingly larger gains."

In general, in dry lot feeding the most rapid and economical gains were obtained from those rations which contained a much larger proportion of protein to carbohydrates and fats than is found in corn.

> The price which feeders can afford to pay for supplementary feeds, rich in protein, to add to the corn ration for the purpose of balancing the same, must be regulated by the percentage of digestible protein contained in them and the market price of corn. When corn is high in price, supplementary feeds, as a rule, can be had at prices which will not prohibit their use; but when corn is very low in price, the feeder will very likely lose a portion, if not all, of his profits in pig feeding through the purchase of supplementary feeds. * * * With feeds at the usual prices, it is an easy matter by their judicious selection to so supplement corn as to add 5 to 15 cents per bushel to the profit from feeding corn, thus effecting a reduction of 50 cents to $1 on each 100 pounds gain in weight by the pigs.

TANKAGE FOR HOGS FOLLOWING CATTLE.[a]

In regions of the West where cattle are fed in large numbers on corn, many hogs are fattened upon the undigested grain found in the droppings of the cattle. B. E. Carmichael, of the Ohio Station, found that of 45 feeders in that State, of whom he obtained definite information, 35 "either used no feed besides that which was not digested by the steers or else gave corn in addition. Since corn is the chief grain used for fattening cattle, it follows that the hogs which depend solely upon the undigested grain in the steers' droppings must be confined to a ration made up almost exclusively of corn. Even if, in addition to corn, other concentrates richer in protein and ash than is corn are fed to the steers, the corn in the droppings is much more readily found, and the benefit derived by the hog from the feeds other than corn is not very great, although it is believed that some benefit may be derived." The feed of the hogs is therefore deficient in protein and ash.

The Ohio Station undertook a series of experiments to determine whether or not the prevailing practice can be improved by supplying a feed comparatively rich in protein and ash to hogs that follow fattening cattle. In these experiments six lots of steers, seven head in each lot, were fed upon two different rations—three lots upon each ration, lots 1, 3, and 5 receiving shelled corn, cotton-seed meal, corn stover, mixed hay, and corn silage; lots 2, 4, and 6 receiving shelled corn, cotton-seed meal, corn stover, and mixed hay.

---

[a] Compiled from Ohio Sta. Circ. 73.

The three lots last mentioned received more corn and more dry roughage than did the lots first mentioned, on account of not receiving silage, which, of course, contained both grain and roughage. All lots of cattle received the same amount of cotton-seed meal daily per steer.

During the first part of the experiment three hogs were put with each lot of cattle; later these hogs were replaced by a thinner lot and four hogs were placed with each lot. The first set of hogs was under experiment for 63 days, the second set for 56 days.

Not a large enough number of hogs was used in any of the lots to eat all of the grain that passed through the steers, although the amount left was in no case great. No corn was fed to the hogs, and, as the cattle feed racks were so constructed as to prevent the grain being thrown out, the hogs secured no grain except that which appeared in the droppings from the steers. * * *

The supplementary feed used in this test was digester tankage, a packing house by-product, of which the hogs in lots 1 and 6 received one-third of a pound daily per head after they had become gradually accustomed to it. The hogs in lots 3 and 4 received no feed other than that obtained from the droppings from the cattle. All lots were kept supplied with a mixture of ashes and salt. It is of interest to note that the lots fed tankage cared less for the ashes and salt than did the other lots.

The tankage was fed in the form of a thin slop, once daily. It may be very conveniently fed in this manner, and was greatly relished by the hogs; in fact, they exhibited an almost ravenous appetite for it.

The gains made by the tankage-fed hogs were more than one-half (52 per cent) larger as well as cheaper than those receiving no tankage.

The results show that a decided advantage resulting from the feeding of the tankage is that fewer hogs are required to consume the droppings from a given number of cattle, and that less time is necessary to produce a given amount of gain, thus both reducing the amount of money tied up in hogs and permitting a more frequent turning of the money.

Aside from these considerations, feeders will readily appreciate the fact that fewer hogs and a shorter feeding period would greatly lessen the liability to loss from cholera. Any method of feeding or management of live stock which makes it possible to reduce the number of animals necessary to furnish a given amount of product, or to cheapen in any other way the cost of production, is worthy of consideration by stockmen. It seems certain that the use of such supplementary feeds as are suggested in this circular will greatly increase the profits from hogs that follow cattle.

While, on account of its cheapness as a carrier of protein and ash and convenience for feeding, digester tankage was used in the work reported herein, it is believed that other feeds, such as linseed oil meal, soy beans, skim milk, buttermilk, or middlings would greatly increase the efficiency of the "cattle hog" in making economical gains. Feeders need, however, to exercise keen discrimination in the purchase of feedstuffs, for there is a likelihood of a heavy demand for certain feeds, making it possible for the manufacturers to raise prices beyond the amount justified by the feeding value.

While further work is needed "to determine what feeds are best suited for this purpose, and in what amounts they should be fed," sufficient has been done "to show that hogs following cattle are often not supplied with the ration best suited for the production of the greatest gains."

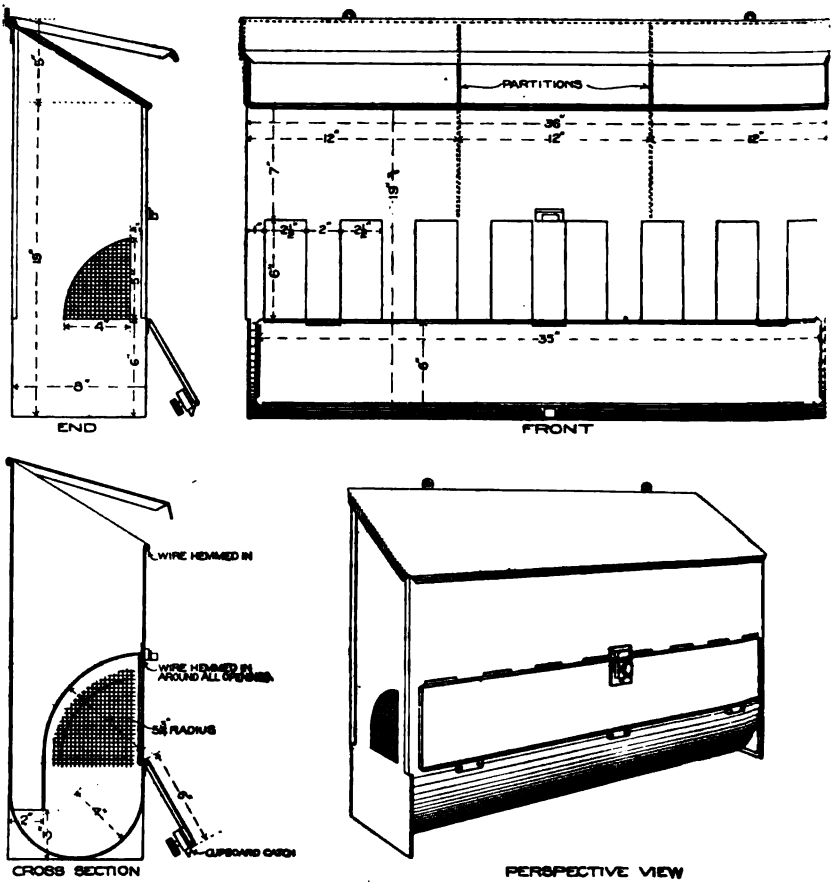

FIG. 3.—The New York feed hopper.

HOPPERS FOR POULTRY FEEDING.[a]

In the dry feeding of poultry, which is attracting considerable attention at the present time,[b] a hopper or some similar device for supplying feed is essential. Hopper feeding, according to J. E. Rice and R. C. Lawry, of the New York Cornell Station, saves labor, guards against underfeeding, and makes the keeping of fowls in large flocks less objectionable because it avoids crowding, which is likely to occur when considerable numbers are fed a wet mash.

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[a] Compiled from New York Cornell Sta. Bul. 248.

[b] See also U. S. Dept. Agr., Farmers' Bul. 244, p. 25.

Experiments which have been conducted at the New York Cornell Station indicate "that for young fowls of the laying varieties, kept for commercial egg production, the feeding of a dry mash in a feed hopper which is accessible at all times during the day is to be recommended."

> Whether the same system of feeding will prove as satisfactory with old fowls of the laying varieties or with young fowls of the general-purpose or meat varieties, we have not yet determined by actual comparative test. Nor has it been proved that the system can be used with safety with breeding fowls. This is a vital consideration. The ultimate test which will decide whether or not the hopper feeding of dry mash will be of universal application to the feeding of fowls, will be the effect on the vigor of the offspring. It is too early yet to decide this point. Many practical feeders, however, conclude from an extended experience that the breeding fowls having constant access to dry mash will not suffer in health from overeating or lack of exercise. We feel certain at this time that hopper feeding when properly employed has genuine merit and will become an established practice. To be successful, however, it must be adapted to suit the various breeds and other conditions as to age, season, and environment.

The authors have devised a hopper for use in the dry feeding of poultry which has been tested at the New York Cornell Station. It consists of a galvanized-iron box, having several compartments, with hinged cover, and on the front openings through which the feed can be reached by the poultry. A curved false bottom separates the upper or storage chamber of the hopper from the trough in the lower part and is arranged so that feed falls in small quantities into the trough. Figure 3 and the following quotation from the bulletin referred to explain the construction of this hopper:

The feed hopper which is used for feeding dry meals, meat scraps, or grain "is made of No. 26 galvanized iron, is 36 inches long, 24 inches tall, and 8 inches wide, divided into three compartments 12 inches wide, and will hold about 60 pounds of meal or 100 pounds of grain. It is built with a slanting top and has a door on the front that hinges up from below to close the opening when it is desired that the fowls should not eat. It is the outcome of a long series of experiments and is the only hopper of a large number tried at the station plant that will not waste feed and yet does not clog. The fact that it has a door to close and that it is made of galvanized iron makes it entirely rat proof. It is placed on a platform 5 inches tall that projects outward 6 inches in front to prevent the litter from being scratched into it. It has been found that one catch in the center of the door is more satisfactory than the two catches." The cost is about $4.

Recent experiments at New York Cornell Station have shown that lime and grit are required at all times by fowls for the best results as regards health and production. It is essential, therefore, that fowls should have access to cracked oyster shells or equivalent material at all times, and it seems also desirable that some other grit and perhaps charcoal should be provided. For this purpose a grit hopper was devised by the authors, which is large enough to make frequent filling unnecessary and is so constructed that it will keep clean and will not clog or waste. It is very similar in construction to the feed hopper described above, except that it is open above the trough instead of closed in. According to the authors, the cost of the hopper, which is made of galvanized iron, should not exceed $1. Figure 4 shows the appearance of the hopper and its method of construction. The rounded back and the overhanging lip in front prevent waste. The slanting top is also noticeable, as well as the eyes at the back, by which the hopper may be attached to the wall. The hopper illustrated is made in three compartments.

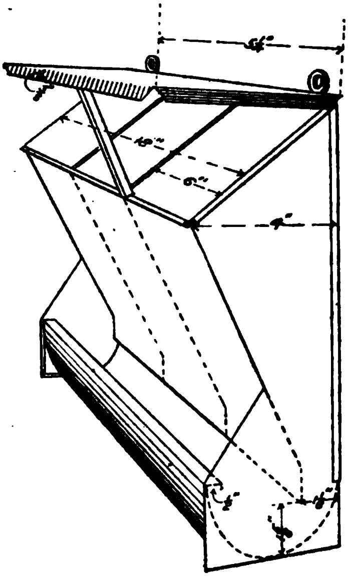

FIG. 4.—The new force-feed grit hopper, with three compartments.

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U. S. DEPARTMENT OF AGRICULTURE.

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FARMERS' BULLETIN 317.

Experiment Station Work,

XLV.

Compiled from the Publications of the Agricultural Experiment Stations.

THE FARM HOME.
LINING OF DITCHES AND RESERVOIRS.
CEMENT PIPE FOR IRRIGATION AND OTHER PURPOSES.
POLLINATION OF FORCED TOMATOES.
INCREASING THE PRODUCTIVENESS OF CORN.
SHRINKAGE OF CORN IN CRIBS.
GRAIN FOR COWS AT PASTURE.
STARTERS FOR RIPENING CREAM.
WATER PANS FOR POULTRY.
CATCHING HOOK FOR POULTRY.

JANUARY, 1908.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

IMPROVING THE CONVENIENCE AND COMFORT OF THE FARM HOME.[b]

The question of sanitary appliances and other conveniences for the farm home has been discussed in a Farmers' Bulletin recently published by this Department.[c] Preparation of vegetables for the table, making of jams and preserves, and various problems concerned with the nutritive value of food and its reference to dietetics have also been discussed in Farmers' Bulletins.[d]

A number of the agricultural colleges and experiment stations have studied questions which have a direct bearing on the convenience and comfort of the farm home, such work in the agricultural colleges usually being done in the home economics department. Dr. Edna D. Day, who has charge of such a department at the Missouri Agricultural College, has recently discussed the need for convenience in the construction of the farm home, the value of labor-saving devices, and related questions.

PLANNING THE HOME.

In this connection she notes that in planning a home it is essential that the rooms should be located with a view to convenience in carrying on household tasks. "Be very careful in making the plans that you put more money into convenience than you do into size. Many a prosperous farmer, on rebuilding his home, has felt rich enough to make a house so large that his wife has not yet found time enough for its proper care. Not only are there more square feet of floor to be swept, but the steps necessary to do the ordinary routine work of the house have been multiplied many times."

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Ann. Rpt. Mo. Bd. Agr., 39 (1906), p. 101; Boston Cooking School Mag., 12 (1907), p. 240; Cornell Reading Course for Farmers' Wives, 3. ser., 1905, No. 14.

[c] U. S. Dept. Agr., Farmers' Bul. 270.

[d] U. S. Dept. Agr., Farmers' Buls. 34, 74, 85, 93, 112, 121, 128, 142, 182, 203, 234, 249, 256, 293, 295, and 298.

In earlier times the farmhouse kitchen, commonly the largest room in the house and usually a pleasant, homelike room, often served as a dining room and living room as well, and one or more of the bedrooms were on the same floor as the kitchen. This meant a saving of time, since the housewife had fewer rooms to care for and fewer steps to take than is the case in the more modern farmhouse with a separate dining room and living room and with sleeping rooms in the second story. The more modern house undoubtedly has its advantages and is in accord with present-day standards of living, but such an extension of space should be counterbalanced by convenience of arrangement, the use of labor-saving devices, and all possible household conveniences.

As Professor Day points out, the proper location of the kitchen and dining room, the china closet, the kitchen sink, stove, and work table means a saving of very many unnecessary steps and much useless labor. If food must be kept in the cellar in summer time a dumbwaiter with two or three shelves running from the kitchen to the cellar is well worth its cost. Of course, an ice box on the ground floor would avoid the necessity for keeping food cool in the cellar. If an ice box is used it should be so located that it can be conveniently filled with ice and yet be near the kitchen. Convenient cellar stairs are much less common than they should be, and their location, lighting, etc., are questions which should always be taken into consideration in house construction.

For use in cold weather ''there should be a pantry on the ground floor in which the food is kept, and this pantry should be within walking distance of the dining room and kitchen. If this is not possible, a box can be turned on its side and fastened just outside the kitchen window and the food kept in it.''

> If your house has been built without care to step saving in the position of dining table, sinks, and cupboards, a small table on rollers, especially if its capacity is increased by a lower shelf, will be found a great convenience. It can be used to advantage in setting and clearing the table. It is also helpful to have near the sink when the dishes are washed. They can be put on it and the table then moved to the china closet and emptied. Many a woman who is now tired of an evening would be fresh if she used [a wheeled table like this and] a high stool at the sink and work table.

A recent writer who discusses the construction and arrangement of a house that may be conveniently cared for by the housewife herself insists that the rooms ''in which daily work is done must be centrally located. Bring the living room near the kitchen and your own bedroom as close to both as possible.'' If a dining room is considered essential it must be conveniently located, but the use of the living room as a dining room in winter and a screened porch for this purpose in summer is spoken of as an alternative.

A cart with compartments and mounted on small wheels is mentioned as a labor saver in the preparation and serving of meals. A an essential, hot water for bath and kitchen use in summer and winter is insisted upon as well as few rooms to take care of, all the rooms being large except the kitchen, for within reasonable limits the smaller the kitchen the fewer the steps which will be taken in the kitchen work.

> The model kitchen has four windows. One whole side of the room is lined with cupboards, some with glass doors, others of solid wood; beneath are drawers and flour bins. The * * * range stands conveniently near the work table, and there is also a large enameled sink with draining board. Between the large screened-in porch and the kitchen is placed the refrigerator, being filled with ice from the outside. The refrigerator doors open into the kitchen. Many times a day the cold storage has to be gone to, and this is an important matter, to have it right at hand. You will find that there is not any more ice consumed in a summer than if the ice chest was in the cellar. Why should steps be multiplied in going to it? The kitchen in the labor-saving planned house is small. The more articles you can reach with fewest steps, the lighter your work will be. * * * A narrow kitchen is a great labor saver. One does not realize this until she prepares a meal in the large square old-fashioned kitchen; the extra steps count as miles in a day.

USE OF LABOR-SAVING APPLIANCES.

The general use of the sewing machine has saved the farmer's wife and other housekeepers unnumbered hours of labor, and in the same way the general use of the proper kitchen conveniences will prove equally advantageous. It is just as important to supply the farmer's wife with carpet sweeper, washing machine, bread mixer, and other labor-saving devices, and with sharp knives, egg beaters, measuring cups, and other kitchen conveniences as it is to use separators in the dairy or other modern appliances in general farm work.

In a summary of data prepared for farmers' wives in connection with the extension work of the New York Agricultural College and Experiment Station, the need for kitchen conveniences is insisted upon. "A clerk does not like a poor pen, a typewriter a poor machine, nor a carpenter a poor saw. So the expeditious cook objects to poor cooking utensils. They are a bar to progress, a menace to the success of her enterprise, and a serious temptation to her serenity of temper. Stirring cake with a small, frail spoon, beating eggs with a loose-jointed egg beater, as well as many other crippling processes, should not be her lot to endure." As the writer quoted points out, the needed utensils cost money, but so do all labor-saving and useful devices, and it is fitting to ask whether the labor-saving devices in the house have kept pace with those purchased for use in the barn or fields. If the farmer's wife and daughters can economize in time and energy required for household tasks they will have leisure for other duties and pleasures and for rest and recreation.

8

FOOD.

Rational living on the farm or in any other community presupposes a reasonable variety of well-cooked foods of good quality with the various sorts in suitable proportion. In many homes the housekeeping is needlessly complicated and the result obtained is out of proportion to the labor expended. In other homes, particularly where the variety of easily obtainable foods is limited and the proper preparation of foods is not given due attention, the diet is too monotonous to be satisfactory or is so prepared that it is not well suited to the family needs. The question of lessening household labor by avoiding unnecessarily elaborate dishes and meals is discussed in the Cornell Agricultural College and Experiment Station publication referred to.

> In our own country the difference between the present table and that of the pilgrim fathers is so great as to account to some extent for the present lack of leisure of the housewife. To fish, brown bread, pork and beans, vegetables, have been added the present salads, ices, elaborate puddings, cakes, and the many forms of dessert. [In the earlier times] * * * there was a regular baking day, when large quantities of baked beans, pies, and bread were prepared.

The baking day and the preparation of large amounts of food at one time, with the consequent economy of labor, are much less common than was once the case. Changes in customs and standards of living and a more varied food supply have led to the selection of many dishes which are best if freshly prepared and to menus which are very often needlessly elaborate. All this means added work for the housekeeper. The careful selection of food and the planning of meals will do much to lessen household labor, and if this is done with due reference to nutritive value of foods and wholesome combinations the results will oftentimes be more satisfactory than is at present the case.

> All are coming to know that simpler living is necessary, not only for the comfort of the housekeeper but for those who sit at her table. Elaborate menus are entirely impossible when one woman does all the work. * * * The elaborate meals and the unnecessary dishes are not for the good of anyone. They interfere with the beautiful grace of hospitality; they prevent the happiness of the cook and the preservation of her strength. Simple, wholesome meals, with intelligent cooking and serving, are a blessing to any household.

In homes where the diet is too monotonous and the preparation of food is not in accordance with right standards of living, the knowledge of proper methods and ways of utilizing available food supplies will result in a much more satisfactory diet with the same amount of labor, or indeed oftentimes with less expenditure of time and energy.

Commenting on the lack of variety in food noticeable on many busy farms and ways in which it may be obviated, Professor Day makes the following statement: "Most farmers have to depend on chickens for the greater part of their fresh meat, and unless one is in the poultry business the care of chickens is another burden added to the household." The increased time which labor-saving devices in the home and convenient construction of the farmhouse make possible would give the farmer's wife time for her poultry, and then poultry keeping need not be a burden. There should certainly be no lack of fresh vegetables on the farm, but frequently the farmer can not give the necessary time to the kitchen garden and the farmer's wife is unable to find time for gardening, though most women doubtless consider gardening a recreation rather than a task. "If only the men can do the first hard work in the garden and see that the indoor burdens are lightened, most women will welcome the opportunity for work out of doors among the green things, and will be the better for it physically."

The above statements make it plain that if the diet is out of harmony with rational standards, either because it is too elaborate or because it is too monotonous or unsatisfactory in other ways, it is possible by the application of knowledge now available to improve conditions and at the same time lessen the housewife's burdens.

> In few departments of home life has there been so much improvement in the last one hundred years in the economy of labor and fuel and in scientific methods as in cookery. It remains, therefore, for the housewife to take advantage of the gain in time and labor to study the kind and quantity really necessary, and the best and simplest way of preparing food, in order that she may have time at her disposal for the other duties in and out of the home and to add to her own leisure and means of self-improvement.

HYGIENIC CONDITIONS AND COMFORT.

Professor Day also calls attention to the need of home conveniences with reference to comfort and hygienic conditions. Flies and other household insects not only make work for the housekeeper, but are active agencies in the spread of disease, and there is every reason why they should be kept out of the house by screens at windows and doors. Much may also be done to prevent the breeding of such insect pests. Proper drains and other sanitary conveniences not only lighten the housekeeper's duties, but are also of the utmost importance in the hygiene of the home.

> The isolated home needs not only to use special care to make its numerous duties easily done, and to be most careful of all health conditions. * * * but it has also special problems in educative recreation.
>
> "Home is peculiarly the place of rest, though the birthplace of all industries." * * * The home has not kept pace with the industrial world in improving the methods of adjusting household affairs. Housework should be carried on with no more loss of time or energy than is involved in the conduct of any well-managed business. To be independent we must sacrifice many of the customs to which we cling. The old order is passing away and the sacredness of home will not suffer, but, instead, we will have a greater development and more opportunities for freedom and happiness.

Recreation and amusement are essential features of a normal life and are as much the right of the farmer's family as of those who live in larger communities, to whom music, art, and many other forms of recreation involving high ideals are more conveniently accessible. However, by means of books, farmers' institute work, lectures, traveling schools, clubs for home study, etc., much that is really best is within the reach of all. The lightening of home burdens by means of a well-equipped and hygienic house, by the use of household conveniences and by the proper understanding and systematizing of home work, means that the home maker and her family may have opportunity for something beside the daily tasks which too often leave neither time nor inclination for recreation.

LINING OF DITCHES AND RESERVOIRS TO PREVENT SEEPAGE LOSSES.[a]

In a recent bulletin of the California Station E. Mead and B. A. Etcheverry call attention anew to the enormous waste of irrigation water due to seepage from ditches and reservoirs. They show from general observation and from a large number of careful measurements that "the water which sinks into the soil from ditches and reservoirs is one of the chief sources of waste in irrigation. In gravelly soils or where ditches cross gypsum strata, the losses sometimes amount to more than half the total flow." Measurements made on a large number of ditches in the course of the cooperative irrigation investigations of the Office of Experiment Stations and the California Station "show an average loss on main canals of about 1 per cent for each mile that water is carried; on laterals the loss amounted to between 11 and 12 per cent per mile; while on some California canals the loss in a single mile was 64 per cent. * * * Measurements made in 1906 on a storage reservoir having a surface of 10,000 square feet showed a seepage loss of 1,000 cubic feet per day. The reservoir is filled by a windmill, and this loss was 10 per cent of the average quantity pumped each day—a loss too heavy to be borne. The problem of this reservoir owner is the problem of hundreds of irrigators. * * *

"The water which escapes is often worse than wasted. It collects in the lower lands, fills the soil, drowns the roots of trees and plants, brings alkali to the surface, and is a prolific breeding place for mosquitoes."

In the course of the same investigations attempts were made to find practical means of lining storage works and canals and ditches to prevent or at least to reduce this waste and consequent loss. "From the results obtained the conclusion was reached that on large and costly aqueducts or important storage works, linings of cement, concrete, or asphaltum may be employed without the expense being prohibitive." It is pointed out, however, that a very large proportion of the irrigation of the country is done by means of the smaller, cheaper reservoirs and other works, the owners of which "can not afford the expense needed to line the reservoir with concrete or asphalt because the value of the water stored will not justify this expense."

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[a] Compiled from California Sta. Bul. 188.

In view of the fact that the greater proportion of the losses occur on lateral ditches and small storage basins, it is necessary to find some simpler and cheaper, but efficient, lining which can be applied by farmers and unskilled laborers. It is clear that the general use of such a method would result in a great improvement of irrigation practice and a marked increase in the duty of water.

Puddling was tried, but as a rule there was not sufficient clay in the soil to make this efficient. A natural silting up, with consequent improvement of water-holding capacity, of reservoirs and ditches carrying muddy water frequently occurs, but a large proportion of the irrigation water used, notably that obtained by pumping, is clear, and therefore no silting results.

Of the large number of available raw materials promising well as ditch and reservoir lining, cement, clay, and crude petroleum were tested as ditch linings in the California experiments. The principal results of the test are given in brief in the following table:

Results of tests of various ditch linings.

Description of lining.	Efficiency ratios.	Saving.	Experimental cost of lining per square foot.	Actual cost of lining per square foot.
		Per cent.	*Cents.*	*Cents.*
Cement concrete, 3 inches thick	7.17	86.6	8.30	7.50
Cement-lime concrete, 3 inches thick	2.90	65.5	8.30	7.50
Cement mortar	2.73	63.3	3.88	3.25-3.50
Heavy oil, 3¾ gallons per square yard	2.02	50.4	1.20	1.20
Clay puddle, 3½ inches thick	1.78	47.8	3.90	1.20
Heavy oil, 3 gallons per square yard	1.50	38.0	1.00	1.00
Heavy oil, 2½ gallons per square yard	1.37	27.3	.77	.77
Thin oil, 2½ gallons per square yard	1.08	7.3	1.00	.80
Earth (no lining)	1.00	0.0		

The table shows wide variations in the efficiency and cost of the different lining materials.

While there is no doubt that cement concrete is the most efficient as regards seepage, it is also the most expensive, being more than six times the cost of the heavy oil lining (3¾ gallons per square yard), which saves 50.4 per cent of the water which would seep were the ditch not lined. This saving with the concrete ditch is 86.6 per cent, or one and three-fourths times as large. Where water is very valuable there is no doubt but that the concrete ditch is more permanent and economical. But where the water is not so scarce and a little waste will do no damage, the expense of lining the ditch with oil may be justified, while a more expensive lining would be impracticable. * * *

The puddle lining in the experiment showed a saving in seepage nearly equal to the heavy oil lining when 3¾ gallons of oil per square yard was used, and a greater saving than the other oil linings. This puddle lining, whose thickness was 3½ inches, would no doubt, if made thicker, be more efficient than any of the oil linings as regards seepage; but clay puddle when wet becomes very soft and will not resist the erosive force of the flowing water unless the velocity is very small. It will not prevent the growth of weeds. For these reasons it is probably not as efficient for canal lining as oil. But where clay is plentiful it would be preferable for reservoir lining. The slopes should, however, be protected against the erosive action of the waves by the use of cobblestones or other protection.

The use of oil in lighter quantities, while not very efficient in preventing seepage, will no doubt prevent the growth of vegetation. * * *

Cement-mortar plaster, so extensively used in southern California, showed a saving in seepage water of 63 per cent. Better results were expected, and it is probably safe to expect a greater saving where good work is done, especially where the work is constructed in cold weather. This lining had to be applied when the temperature in the field was probably 110° or over. The cement mortar was mixed in small quantity and quickly applied. As soon as the setting had started the lining was sprinkled and covered with wet canvas, but even with these precautions better work could be done in cooler weather.

This plaster, while very efficient and economical on small ditches, would not be of sufficient thickness and strength to be used on the larger canals and laterals of larger irrigation systems, where a thickness of from 2 to 4 inches would no doubt be successful.

CEMENT PIPE FOR SMALL IRRIGATING SYSTEMS AND OTHER PURPOSES.[a]

The need of better methods of using the limited water supplies available in many parts of the irrigated region, as illustrated by conditions in certain localities in Arizona, is thus presented by G. E. P. Smith in a bulletin of the Arizona Experiment Station:

Throughout southern Arizona there are scattered many sparsely settled valleys traversed by the characteristic rivers of the arid region. These rivers are normally dry beds of sand, but at intervals they carry great floods of water. In most cases the soil, both of the bottom lands and the adjoining mesas, is fertile and easily cultivated, climatic and other conditions are good, and the markets are excellent. The water supply, however, is so slightly developed that agriculture is a very precarious business. Winter crops are sown with a large element of doubt as to whether harvests will be reaped, and through the summer much of the same land is not utilized at all while adjacent areas of great productive capacity are still wastes of mesquite and catclaw. The water supply already developed in these valleys is largely derived from small ditches heading in the sandy river beds. A few pumping plants have been installed in favored localities.

While the area of irrigated land is being rapidly extended throughout the West and many monumental enterprises are being developed, yet the smaller valleys above referred to seem to have been neglected and very little change has been wrought since their occupation began.

Without asserting that there are unlimited, or even abundant, water supplies for these valleys, yet it is demonstrably true that their cultivation can be very greatly extended, not only by largely increasing the water supply, but also by the adoption of modern methods in the development, distribution, and use of irrigating streams. At present the settlers are confronted with the many problems relating to such improved methods. The mountains must be surveyed for reservoir sites, the valley gravels

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[a] Compiled from Arizona Sta. Bul. 55.

> must be explored and studied to locate and secure the water which they can yield, pumping plants must be more intelligently designed, for great economics are possible in their design and operation, the water must be saved from loss by seepage and evaporation in ditches, and the ground must be so mulched and cultivated as to conserve the water after it has been applied to the fields. It is no extravagance to say that by careful methods the present very low duty of water in these valleys can be more than doubled.
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> One of the most experienced irrigation engineers[a] in the West has recently stated that, of the millions of dollars spent annually by our irrigated districts for water and for applying it to cultivated crops, fully 70 per cent of the money is wasted. What an opportunity is thus offered for investigation. What an argument for the introduction of methods that may result in utilizing a part of that 70 per cent which at present is not put to any beneficial use. It seems imperative that agricultural interests should join in a campaign for a higher duty of water. The main purpose of this bulletin is to discuss one phase of this campaign, namely, greater efficiency in transmission and distributing systems.
>
> The same authority quoted above states that as a rule cultivated fields do not receive more than 66 gallons out of every 100 gallons of water which pass through the upper headgates, the rest being lost by seepage and evaporation. In Arizona the river beds and banks are usually of very porous sand and the ditches leading through these deposits suffer great loss of water. Occasionally the extreme case occurs in which the entire flow is thus lost. * * *
>
> In seeking a remedy it is to be observed that seepage losses can be stopped by proper lining for ditches, while both seepage and evaporation are prevented by closed conduits. The materials available for these purposes are wood, cement, and clay. All have been employed in various parts of the West. The only one tried so far in southern Arizona has been wood; but its short life and the warping and leaking which it undergoes, together with high cost, unfit it for use in ditches. Cement pipe for small ditches and cement lining for large ones are from every point of view to be recommended. Clay tile lacks strength, and since at present it is subject to long freight hauls, its cost is very much greater than that of cement pipe. The latter is composed largely of sand and gravel found in the vicinity of the ditches and only the cement ingredient is subject to a freight charge.
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> There are other advantages in piping ditch waters besides the prevention of seepage and evaporation. The maintenance of open ditches is very difficult. Under the subtropical skies of Arizona weeds and algæ grow rankly and unless removed at frequent intervals they soon obstruct and diminish the flow. The Flowing Wells ditch near Tucson costs $80 per mile per year for cleaning alone. Furthermore, gophers perforate the ditch banks and cause the waste of rivulets for days or even weeks before the holes are discovered. Sometimes the holes enlarge and the ditch bank breaks, with consequent loss of the entire stream. The maintenance of cement pipe lines should be very slight.

To determine the practicability of making cement pipes and the best mixtures and methods to be used, Professor Smith established a small plant and made six different lots of 15-inch pipe, "this size being of such capacity as to adapt it to many streams belonging to individuals or small companies of ranchers." Using a very lean mixture of cement, lime paste, and sand, the paste being thinned to a consistency that permitted it to mix thoroughly with the sand, for the body of the pipes, and a mixture of 1 part cement and 3 parts sand for the bell ends, very satisfactory results were obtained.

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[a] Samuel Fortier, Irrig. Age, 21 (1906), p. 375.

The method of molding is described in detail. Several molding forms are on the market and can be rented by paying a small royalty. The molding outfit used in the experiments described contained molds for both bevel and tongue, and bell and spigot joints, and cost $60. "It could be made ample for continuous operation at 40 tile per day for $75 more."

The results of accurate observations on the cost of cement-sand and cement-lime-sand pipe are recorded in the following table:

Cost per 2-foot length of 15-inch pipe.

	Cement-sand.	Cem- lime-
Cement at $4.50 per barrel	$0.563	[illegible]
Cement, hauling 7 miles	.035	[illegible]
Lime at $13 per ton, delivered	....	[illegible]
Sand, no charge	....	....
Water, no charge	....	....
Labor: Foreman, $2 per day; 2 laborers at $1.25 per day	.112	[illegible]
Wash of neat cement	.060	.....
Cost per 2-foot length	.770	[illegible]
Cost per linear foot	.385	[illegible]
Cost per mile	2,032.80	1,[illegible]

"Being made in close proximity to the river sand and within 2[illegible] feet of an irrigating ditch, no allowance is made for sand or water. [The] figures are based on Tucson prices during April, 1907, and must be modified to conform to the local prices at points where cement pipe lines are contemplated. * * * In some cases a considerable allowance should be made in the estimate for sand."

Observations on the construction of a redwood flume built in the same vicinity and at the same time as the cement pipe show that the cost of a flume of capacity (12 by 16 inches) equal to that of 15-inch pipe would be 25 per cent greater than the cement-sand pipe and 70 per cent greater than the cement-lime pipe, the differences amounting to $528 and $1,061 per mile, respectively. It must be borne in mind, too, that the chief advantages of the cement pipe are greater permanence and less loss of water by leakage.

The comparative merits of such pipe, clay tile, and concrete, crude oil, asphaltum, and puddled clay are discussed, the cement pipe being considered to possess decided superiority in many respects, particularly for the local conditions. The cement pipes are also shown to have a variety of other important uses.

The following example of the financial advantage of piping water in Arizona (and similar conditions are not uncommon elsewhere in the arid region) is cited:

> In a certain ditch carrying about 100 miner's inches through sandy deposits, the loss of water per mile exceeds 10 per cent, say 10 miner's inches, capable of irrigating an additional 30 acres on the ranch, which would yield a net profit, estimated at $30 per acre in alfalfa, of $900 per year. This water could be carried in a 15-inch

pipe line costing $2,500 laid, the interest on which at 8 per cent would be $200. The maintenance of the pipe should be very much less than that of the open ditch; the frequent cleaning of the weeds and algæ would be entirely eliminated. The net profit resulting from the pipe line would therefore be $700 per annum.

POLLINATION OF FORCED TOMATOES.[a]

It is well known that greenhouse tomatoes do not set fruit freely during the midwinter season. The only satisfactory method for correcting this trouble is to fertilize the blossoms by hand. A description of this method, together with a discussion of the conditions favorable for pollinating, is given in a Farmers' Bulletin on "Tomatoes" of this Department.[b] It is here desired to emphasize the importance of pollinating carefully and thoroughly. In house-grown tomatoes there is often a considerable percentage of one-sided fruit and of small fruit, which greatly detracts from the value of the crop. The general inferiority in size of winter-grown tomatoes can undoubtedly be attributed to the comparatively short periods of sunshine during that season of the year. On the other hand, the results of station investigations along this line show that imperfect pollination is an important cause of one-sided and small fruits. While working at the Cornell Station, W. M. Munson found that the amount of pollen used may have an important bearing in determining the form and size of the fruit.

> In the winter of 1890–91, while crossing tomatoes, two stigmas in the same cluster of flowers were given different amounts of pollen. The first was given a very small amount—10 to 20 grains—on one side of the stigma; the other was given an excess of pollen, the stigma being well smeared. The effect on the form and size of the fruit was very marked. The fruit receiving the large amount of pollen was of normal size and nearly symmetrical in form, while the other was small and deformed. The larger fruit produced an abundance of seeds and all of the cells were well developed; the smaller developed seeds on one side only, while the other side was nearly solid.

The experiments were repeated several times during the following winter, and similar results were obtained, both when "the flower nearest the base of the cluster received an excess of pollen, while the other received a very small quantity on one side of the stigma" and when "the flower at the base received the small amount of pollen, while the other was given an excess," thus indicating that the relative position of the flower had no influence in determining this point.

No conclusion was reached by Munson as to the exact number of pollen grains necessary to insure proper fertilization, but in no case was fruit secured "when all pollen was excluded, and in every case the size of the fruit was in direct proportion to the amount of the pollen used."

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[a] Compiled from Maine Sta. Rpt. 1892, pp. 48–51; Indiana Sta. Rpt. 1904, p. 17; Michigan Sta. Spec. Bul. 39; New York Cornell Sta. Bul. 28.

[b] U. S. Dept. Agr., Farmers' Bul. 220.

Experiments with greenhouse tomatoes, recently reported from the Michigan Station by S. W. Fletcher and O. I. Gregg, not only confirm the results secured by Munson, but also appear to show, as indicated by earlier experiments by J. Troop of the Indiana Station, that there is no decided advantage to be gained by the cross pollination of varieties as compared with self-pollination. Six varieties of tomatoes were included in these experiments, viz: Ignotum, Stirling Castle, Earliana, Best-of-All, Lorillard, and Frogmore. "Four plants of each variety were used * * * to determine the effect of using varying amounts of pollen. All the flowers on one plant of each variety were emasculated and pollinated on one side of the stigma only. These invariably produced lop-sided and small fruits. All the flowers of one plant of each variety were pollinated with from one to five pollen grains. These produced very small, solid fruits, with an average weight of but 34 grams (about 1 ounce) and having no seeds, or but one or two. All of the flowers on one plant of each variety were pollinated with a large amount of pollen, spread all over the stigma. These produced fruits that were smoother and averaged 12 grams heavier than fruits produced from flowers that had but a small amount of pollen applied all over the stigma." The conclusions deduced from this work are that "when pollen falls upon one side of the stigma only, a one-sided tomato always results. The larger the stigma the greater the irregularity. The amount of pollen applied to the stigma determines to a great extent the size and smoothness of the tomato; but after applying a certain amount of pollen no further increase in size or weight results by applying more. The small, irregular tomatoes grown under glass are caused largely by insufficient pollination."

With the view of throwing some light on the relative value of cross and self pollination, "the blossoms on four plants of each variety were self-pollinated, and the blossoms of eight plants of each variety were cross pollinated with two other varieties. All set fruit equally well. The 265 fruits produced from self-pollination on all six varieties had an average weight of 77.3 grams. The 534 fruits produced from cross pollination on all six varieties had an average weight of 79.1 grams," from which it will be seen that there was practically no gain in the total number of cross pollinated fruits secured, and but a slight difference in the weight of the individual fruits in favor of cross pollination.

Although it does not appear necessary to raise several varieties for the purpose of cross pollination, there is no harm in alternating such varieties as are grown, and in some cases a possible benefit may be obtained, such as a slight increase in the average weight of the fruit.

All of the experiments, however, do show most conclusively that the setting of a good crop of smooth, heavy fruit depends very largely upon the care taken in distributing the pollen, especially during the cloudy weather which is likely to be of frequent occurrence in midwinter.

INCREASING THE PRODUCTIVENESS OF CORN.[a]

The production of every crop is influenced by many different factors, and in so far as these are under control the yield may be increased and the fertility of the land maintained or improved. It is necessary, therefore, to take all the different factors into consideration to reach the maximum production. In a recent bulletin of the Kansas Experiment Station, Professors Ten Eyck and Shoesmith describe the results of a series of expermients with corn carried on for four years, in which the more important factors entering into the production of larger and more profitable crops were taken into account.

VARIETIES.

During the period of the experiments 112 varieties of corn were planted for trial and comparison. The methods of cultivation for the last three years of the variety test are described. In 1904 the land was disked twice from March 10 to 15 for the purpose of conserving the soil moisture, and a second disking was given April 29 to May 2, just prior to listing the corn in furrows about 5 inches deep, with the rows 3½ feet apart and the kernels 16 inches apart in the row. For the test in 1905 the land was plowed November 24 to December 10, harrowed March 29 and again April 10, and the corn planted with a planter on April 28 and 29 at the same distances used in 1904. In 1906 the varieties were planted after winter wheat, followed by rape in the stubble after harvest, which was plowed under when about 16 inches high near the middle of October. The land was disked soon after plowing and was harrowed twice in the spring before planting. The corn was planted May 2 to 4 in the same manner as the year before.

Of all the varieties tested Hildreth, Kansas Sunflower, McAuley, Forsythe Favorite, Golden Row, Hammett, Leaming, U. S. P. B. Selection No. 77, Hogue Yellow Dent, Sander Improved, White Salamander, Red Cob White Dent, White Injun, Legal Tender, Warner, Mammoth Golden Yellow, Dyche, Meinhardt, and Hiawatha Yellow Dent were superior in productiveness. The ten most productive varieties in the three years, 1904–1906, ranged in average yield from 57.81 to 61.25 bushels, and the ten highest for the four years from 58.05 to 65.21 bushels per acre. In 1905 the 75 different varieties tested matured in 121 to 143 days, the average period being 129 days. Of 35 varieties grown for four years the 16 which required 126 days or less to mature gave an average yield of 61.45 bushels, while the rows requiring 127 or more days yielded on an average 64.94 bushels per acre.

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[a] Compiled from Kansas Sta. Bul. 147.

White Injun, which held the highest 3-year record, is a red-cobbed white dent and a selection from Red Injun No. 81, originally selected by the station for breeding on account of its deep kernels and well-filled butts and tips. Red Cob White Dent, a hardy variety of medium growth and maturity and fairly uniform type, is considered valuable for general planting. McAuley, which also ranked high as a good yielder, is a white dent of fairly uniform type resembling Boone County White. It is described as medium late in maturing, of vigorous growth, hardy, and well suited to bottom land or fertile upland. Golden Row and Hogue Yellow Dent, received from the Nebraska Experiment Station, appeared to be well adapted to the northern part of the State.

The results of the variety tests also showed that Kansas-grown corn is better adapted to Kansas than seed corn from other States, although pure bred and highly productive. It is recommended that the varieties generally grown within the State be more extensively tested and improved and that some of the best varieties from other States be thoroughly adapted to the conditions prevailing in Kansas before their general dissemination.[a]

MOISTURE CONTENT.

After husking, the percentage of moisture in the different varieties of corn was determined by drying the kernels and cobs separately in an oven at 110° C. In 1904 the moisture content in the ear corn ranged from 11.90 to 29.02 per cent, in 1905 from 11.66 to 21.86 per cent, and in 1906 from 10.73 to 19.43 per cent. The data secured are taken as indicating that under Kansas conditions well-cured ear corn put into the crib in the fall contains on an average about 15 per cent of moisture.

METHODS OF CULTURE.

A comparison of different methods of preparing land for corn was begun in 1903. Early in April one plat of corn stubble land was double disked, another double disked and harrowed, a third listed in furrows 3½ feet apart, a fourth plowed and harrowed after plowing, and a fifth received no treatment. Early in May all plats were planted with a lister. On plat 3 the ridges were split at planting time, the corn being planted in the newly listed furrows. In 1904 and 1905 several additional treatments were introduced. One plat was plowed 6 to 8 inches deep, another 3 to 4 inches deep, and both were planted with the surface planter. In another set of plats the first was plowed and planted with a lister, the second was listed early and the corn planted in the same furrows, and the third was treated the same as plat 3, described above. These different treatments were always given as soon as the soil was in condition for cultivation. The results of these different methods of preparing the seed bed showed that listing early in the spring and splitting the ridges at planting time gave an increase in yield of 5.02 bushels per acre over land receiving no early treatment. No difference in the average yield apparently due to other early treatment was observed. During the four seasons surface planting yielded on an average 6.65 bushels more corn and 469 pounds more stover per acre than listing.

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[a] See also U. S. Dept. Agr., Farmers' Bul. 244, p. 7.

In a single trial in 1905 surface planting with a disk furrow opener attachment yielded 53.24 bushels, ordinary surface planting 51.94, and listing 48.33 bushels per acre. The furrow opener is a device intended to secure the advantages of listing corn without all of its disadvantages. It was observed that the corn planted with the disk furrow openers sprouted quicker and made a more vigorous early growth than surface-planted corn, and that it retained this advantage throughout the season.

There is an advantage, also, in cultivating the disk-furrow planted corn similar to that secured by listing, in that the weeds in the row are more easily covered and destroyed by the early cultivation than is the case with surface-planted corn. Also, there may be a similar advantage, as obtained by listing, in that the corn roots lie relatively deeper in the soil and are covered with a greater depth of mellow soil at the last cultivation when the corn is laid by. It is well to remember, however, that when the furrow openers are used it is necessary to plow the land and prepare a good seed bed the same as for surface planting, and also that it requires four horses to operate the corn planter with the furrow-opener attachment.

The soil moisture determinations made show without exception that listing as compared with surface planting favored the conservation of soil moisture in the latter part of the season. This result is considered as possibly due to the larger growth of surface-planted corn, to the level culture given listed corn and the slight hilling of the surface-planted crop, and to the last cultivation of the listed corn being uniformly deeper than in the case of the surface-planted plats.

For two years tests were conducted with planting at different dates, and the average results show that planting May 26 gave the best yields, and that the May plantings gave better results than the April plantings.

Cultivation experiments were conducted only with surface-planted corn. Four cultivations were given each season. One plat was cultivated shallow and another deep throughout the season and on two plats the first two cultivations on the one were shallow and the last two deep, while on the other this plan was reversed. Shallow cultivation was about 1½ inches and deep cultivation about 3½ to 4 inches deep. The disk cultivator and the weeder were also used to some extent in these tests. The average yields for the several seasons did not vary much and the results are taken as indicating that the exact method of cultivating is not so important as the conditions of soil and season. It was observed, however, that each season the shallow cultivated corn matured several days later than the deep cultivated corn, and further that in case of the shallow cultivation laying the corn by was a decided advantage, the average yields of stover being the greater on the plats receiving this treatment. The weeder proved effective on mellow soil when the weeds were small, but on hard ground with large weeds it did not take the place of a good cultivator.

FERTILIZERS.

In comparative fertilizer tests carried on in 1906 the largest yield, 56.63 bushels per acre, was secured on land treated with 13 tons of barnyard manure per acre. The next largest yield, 40 bushels per acre, was obtained on a plat treated with 50 pounds of nitrate of soda applied broadcast. The average production of the unfertilized land was 33.21 bushels per acre.

ROTATIONS.

The following crops were grown in rotation: Wheat, wheat followed by cowpeas as a catch crop, oats, barley, emmer, flax, millet, sorghum, Kafir corn, corn, corn followed by cowpeas as a catch crop, corn followed by rye as a catch crop, soy beans, and potatoes. The arrangement was such that each year corn was grown after the various crops and the various crops after corn, and the object of this rotation test was to study the effect of each of these crops upon the growing of corn. The data secured show that the largest average crop of corn, 69.98 bushels per acre, was grown after potatoes. The second largest yield of corn, 67.55 bushels per acre, was produced after soy beans and the third largest, 60.74 bushels, after corn. After the other crops the yields were smaller than where corn was grown after corn, the lowest yields being produced after Kafir corn and sorghum. In average value of total products the rotation of corn with potatoes ranked first, with $43.47 per acre, the corn being valued at $20.99 and the potatoes at $22.48, corn after Kafir corn second, with $34.16 per acre, corn after sorghum third, with $31.15, and corn continuously fourth, with $31.07. While the lowest yields of corn were produced after Kafir corn and sorghum, the large yields of these crops made the value of the total production from these rotations relatively high

The plats growing corn continuously, in which rye was sown each fall ranked third in average yield and fourth in value of total production.

A catch crop of rye in corn helps to eradicate weeds, utilizes available plant food left in the soil in the fall which otherwise might be washed out or drained away, provides a protection to the soil through the fall and winter, thus preventing the soil from blowing, catching the rain, and stopping the drifting snow. When corn follows rye in this way it is necessary to plow or double list, and this should be done rather early in the spring, unless it is preferable to plow late in the fall. If rye is plowed under late in spring, the seed bed is apt to be left loose and dry, and if corn is listed in rye, the rye becomes a troublesome weed which is difficult to destroy and which may injure the growth of the corn.

The sowing of rye in the corn seemed to give better results than the catch crop of cowpeas, but a marked increase in yield of corn after wheat and cowpeas, amounting to 8.76 bushels per acre, showed the value of this crop as a fertilizer when grown between small grain and corn. The apparent advantage of rye over cowpeas in this test is considered due to the fact that the rye, having been sown late, did not compete with the corn for moisture and plant food to the same extent as the cowpeas, which had been sown earlier in the season. None of the rotation systems tried are regarded as ideal, as a practical and scientific rotation is intended not only to produce large yields, but also to maintain the fertility of the soil, and that such a rotation would include grasses and perennial leguminous crops, as well as the growth of annual leguminous plants and catch crops.

BREEDING.

In corn-breeding work the station found in some tests a difference of more than 400 per cent of the yields from different ear rows. In 1906, the Silvermine high-yielding-rows seed plat yielded 32 per cent more corn and 24.8 per cent more first-grade seed ears than the plat planted with first-grade seed. The Hildreth high-yielding-rows seed bed yielded 10.36 per cent more corn and 40 per cent more first-grade seed ears than the plat planted with first-grade seed of this variety. It is pointed out that the results of the breeding work show that the individuality of certain ears can be utilized in the improvement of a particular breed or variety. The breeding stock of Kansas Sunflower corn, after four years' breeding by the station, traces back to two original mother ears. Germination tests indicated that ears of corn may vary greatly in vitality regardless of selection and preservation, and that it is therefore very important that each ear of seed corn be subjected to germination tests in order to remove those of low vitality.

SHRINKAGE OF CORN IN CRIBS.[a]

In connection with the marketing of many farm products shrinkage is always an important consideration. Farm crops generally are subject to shrinkage when put in storage after harvest, but it often amounts to so little that it is entirely disregarded. In ear corn and hay, however, the loss of weight during storage may be quite large, and with these crops, therefore, shrinkage is as a rule taken into account. That ear corn generally sustains important losses in weight during storage is so commonly acknowledged that in many localities the custom prevails of taking 75 pounds of ear corn for a bushel in the fall and only 70 pounds in the spring. Observations on the shrinkage of stored crops have been made by several of the experiment stations, and the results have been noted in a previous bulletin of this series.[b]

In some of the more recent work along this line by the Illinois Station the purpose was to ascertain whether it would be more profitable to market corn as early as possible after husking or to hold it until winter or spring before selling it. Not only the losses in weight were determined, but the increases in price necessary to compensate for these losses were also calculated.

For the purpose of making these observations on the shrinkage of stored ear corn cribs were constructed at Urbana and Sibley in such a manner that they could be lowered to rest upon the platforms of large wagon scales and weighed. At Sibley a check experiment was made by weighing each wagonload of corn as it was put into a stationary crib constructed of ordinary fencing lumber on blocks and weighing out all the corn when the crib was emptied at the end of the trial. The first year the shrinkages of the two cribs at Urbana and Sibley varied between 12.3 and 19.8 per cent.

The data secured from other weighings and also the results from some preliminary trials are reported. On December 6, 1901, 20,545 pounds of corn were weighed into a crib at Sibley and weighed out again September 25, 1903, when the weight was found to be 18,690 pounds. The loss in weight amounted to 1,855 pounds, or 9 per cent for the entire period of over 22 months. Another crib close by, receiving the same amount and kind of corn and filled and emptied on the same dates as the other, showed a loss of 1,895 pounds, or 9.2 per cent. In still another test a stationary crib was filled during the week preceding November 11, 1905, with 19,850 pounds of ear corn. November 3, 1906, when the corn was taken out of the crib it weighed 17,280 pounds, showing a loss of 12.9 per cent for the year. Taking all the trials into consideration the loss in weight of the corn in the different cribs ranged between 9 and 20.7 per cent for nearly two years' storage.

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[a] Compiled from Illinois Sta. Bul. 113; Kansas Sta. Bul. 147.

[b] U. S. Dept. Agr., Farmers' Bul. 149.

The data secured also indicate that the shrinkage for the second quarter of the year was not much in excess of that for the first, the difference being an average of only 2.10 per cent. The shrinkage for the third quarter, however, was noticeably greater than that of the second, the average difference being 8.70 per cent, while the shrinkage for the last quarter from June to September averaged only 2.10 per cent. It was found that by far the most noticeable shrinkage of ear corn in the cribs occurred during the months of April and May, after which period the corn sustained only a gradual loss.

The observations made on the loss in weight during the second year of storage point to the fact that practically all moisture comes out of ear corn during the first year of storage. In a trial at Sibley continued through the second year the shrinkage was 19.6 per cent at the beginning of the year and had only increased to 20.5 per cent by the following September. At Urbana the corn also lost 1 per cent in weight during the second year. From these results it is concluded that it seems safe to assume that old corn may be stored in cribs with very slight loss from shrinkage. The weekly weighings showed that the crib weights were influenced by the amount of moisture in the atmosphere.

In determining the increase in price that must take place between cribbing time and the following December, March, June, and September, it was assumed that the corn might have been marketed at cribbing time for 35 cents per bushel, and the average of the "high" and "low" Chicago cash prices for December and May as summarized from the Yearbook of this Department for 1905, which shows a difference of 3.8 cents per bushel in favor of May, was also taken as one of the factors in the calculation. Furthermore, it was pointed out that this average difference in price and the allowance of 5 pounds per bushel for shrinkage would make the actual average rise in price between May and December 6.3 cents per bushel. This computation shows that when the percentage of decrease in the weight of ear corn up to and including September of the first year runs from 12 per cent to nearly 20 per cent, as in the four different trials under consideration, an increase in price for September varying between 4.9 and 8.6 cents per bushel is necessary to cover the loss in weight and to insure the farmer against financial loss in holding his corn. In two of the trials the decrease in weight between December and June was greater than would be covered by the average increase in price of 6.3 cents between December and May, while in the other two trials it was smaller, so that the average increase in price, including the usual 5 pounds decrease in the number of pounds taken from 1 bushel, is considered as possibly covering the average shrinkage.

At the Kansas Station shrinkage experiments were conducted for three years in three small board cribs holding about 4,000 pounds of ear corn each. The cribs were lined with fine wire netting in order to confine the loss in weight as much as possible to the actual shrinkage of the stored corn. They were filled each fall when the crop was in good condition for storing with Forsythe Favorite and McAuley, white dent varieties, Reid Yellow Dent, Kansas Sunflower, and Hildreth, yellow dent varieties, and with mixed corn consisting of a few bushels each of many different varieties.

In 1903 the white corn at husking time contained 24.94 per cent of moisture and the yellow corn 19.73 per cent. The corn lost 2.33 per cent in weight on the average during the first month, with but little decrease in weight during the rest of the winter, but by May 6 the total average loss for all cribs had reached 6.14 per cent. The yellow corn showed a loss of 5.66 per cent in the last month of the trial, but in the other tests the weight of the corn remained about the same through the summer. The final weights showed a shrinkage of 7.92 per cent as an average for eight and one-half months for all cribs. The white and yellow dent corn lost on the average 3.79 per cent more in weight than the mixed corn.

In 1904 the corn ripened earlier than in 1903 and the first comparative weights were taken October 26, as compared with December 5 in the previous year. The white corn contained 18.95 per cent of moisture and the yellow corn 21.32 per cent when put into the crib. On January 31 the average loss in weight in all cribs was 5.17 per cent, the yellow corn showing the greatest decrease. Again, there was little loss in weight during the winter but a great shrinkage in weight during the spring and early summer months. The lowest weights for the year, with the exception of yellow corn, were recorded on June 20, the average shrinkage at that date being 11.32 per cent. The final weights taken October 7 showed an average shrinkage of 12.21 per cent. As in the year before the mixed corn again lost least in weight, the ratio of shrinkage being 6.72 to 14.88 per cent for the yellow and white corn. On July 20 and August 24 an actual gain in the average weight of the cribs was recorded and the mixed corn continued to gain from August 24 to the end of the test.

In 1905 the first comparative weights were taken November 16. By December 23 the cribs had lost only about one-half of 1 per cent of weight on the average and the crib of white corn had actually gained in weight. On February 6 the average shrinkage was 2.26 per cent and on April 19, 3.86 per cent. All cribs gained in weight during May, after which there was a gradual decrease in weight until October 16, when the final weights showed an average shrinkage for the entire test of 5.82 per cent in eleven months. The yellow corn showed a loss of 8.48 per cent in weight, the mixed corn of 6.42 per
white corn only 2.44 per cent during the whole period.

Five samples of white corn at husking time contained on the average 15.2 per cent of moisture and a single sample of Reid Yellow Dent, husked a little earlier than the white, contained 18.9 per cent.

It is pointed out that the average results indicate that when corn is put into the crib fairly dry and in good condition the shrinkage during the winter months is not great, being a trifle over 5 per cent as an average for the first six months after the corn was cribbed, and that this loss would not be sufficient usually to equal the difference in weights which are required for a bushel of ear corn as sold in the fall and as it may be sold in the winter or early spring. It is believed that the loss on the original weight in the eight or ten months is not so great as the decrease in the actual value of the corn, when considering that at husking time the price is often more than 10 per cent less than in the spring or early summer. The total shrinkage of weight in a year of the nine cribs of corn was only 8.62 per cent. Attention is called to the fact, however, that precaution was taken to avoid loss in weight from other causes than shrinkage.

As to whether the farmer should hold his corn or sell it early in the winter may depend upon several factors, as the price of corn, size of the general crop, condition at husking time, and the accommodation which the farmer may have for saving his crop. If the crop is normal and the price of corn is unusually low at husking time, and the farmer has a good crop, the usual recommendation would be to hold the corn. Judging from these experiments corn may be kept safely without great loss in weight until March or April, and if there is a question as to the success of the new crop it may be advisable to hold old corn even later than the date named. However, in Kansas, and in States farther south, old corn is very apt to become infected with the grain weevil or grain moth and great loss occasioned in this way, provided the corn is held too late in the summer. In the northern States, where these pests do not prevail, corn may be safely held for late summer and early fall sale.

The results of the tests also indicate that the shrinkage in corn is not due entirely to the loss of moisture, but that there is an actual loss of dry matter. Samples of Forsythe Favorite cribbed in 1904 contained on October 25, 1905, 11.87 per cent of moisture in the grain, 12.85 per cent of moisture in the cobs, and 12.05 per cent in the ear corn, and a sample of ear corn taken from the seed-corn room on this date contained 11.42 per cent of moisture.

The shrinkage in the weight of the white corn in 1904–5, due to loss of moisture, could not have been more than 6.9 per cent, since the new corn contained only 18.95 per cent of moitsure when it was put into the crib. However, the white corn actually lost 14.48 per cent in weight in the trial referred to, and it will be observed that in almost every case the shrinkage in the weight of the corn was greater than may be accounted for by the loss of moisture.

Hildreth corn cribbed in the fall of 1906 contained 19.75 per cent of moisture in the ear corn and separate determinations showed that the grain contained 17.72 per cent of moisture, while the cobs contained 29.36 per cent. The sample contained 82.6 per cent of shelled corn and 17.4 per cent of cob. From these data it appears that the cobs and grain become about equally dry in old corn. "If the mi mum moisture in the dry corn reaches 12 per cent this would g a shrinkage of 5.72 per cent in the grain and 17.36 per cent in th cobs, or an average shrinkage of 7.75 pounds for each hundred pound of ears, and 3.02 pounds of this shrinkage, or 39 per cent of the tot shrinkage, would actually occur from the drying out of the cobs."

FEEDING GRAIN TO MILCH COWS AT PASTURE.[a]

Under advanced methods of dairy farming it is recognized as essen tial to the greatest success to maintain the highest and most unifor flow of milk practicable throughout the year. Now, when g pasturage is available the change from barn feeding to pasture is a rule highly beneficial, both as regards yield and quality of milk an health of the cows, but even in good grazing regions there are frequentl parts of the season, usually late summer, when the pastures are ap to become dry and thus make it a matter of much practical importance to find some means of keeping up the milk flow. For this purpose the practice of feeding either grain or soiling crops to supplemen the pasture has been suggested. The economy of feeding grain t cows at pasture has been a subject of investigation by several of th experiment stations.

In experiments at the Kansas Station a number of years ago "tw lots of cows each were fed alternately on rations consisting of pastur alone, pasture and bran, pasture and corn meal, and pasture an ground oats, for periods of seven days each." The conclusion wa that although the grain feed added materially to the milk yield, cor meal showing the greatest increase, the increased returns did not pa the cost of the grain. In fact there was a considerable loss.

In experiments at the New York Cornell Station one lot of cow was fed, from June 8 to September 21, a daily ration of 2 pounds o cotton-seed meal and 2 pounds of bran per cow, and another lot wa fed, from May 25 to September 17, 6 to 9 pounds daily per cow of a mixture of wheat bran 100 pounds, cotton-seed meal 100 pounds, an malt sprouts 15 pounds, in addition to good blue-grass pasture. In neither case was there any profitable return in milk or butter for th additional grain fed.

In experiments with cows soiled in the barn on fresh grass ther was an increase in the milk and butter production and a saving in grass barely sufficient to pay the cost of the added grain ration.

To determine whether the profit from grain feeding would be greater in case of poorer pasturage a herd of cows on light pastur was divided into two similar lots, one lot receiving only pasture an soiling, the other, beginning May 23, was fed 4 quarts per cow daily

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[a] Compiled from Mississippi Sta. Rpt. 1900, p. 31; New York Cornell Sta. Buls. 1 22, 36, 97.

(two feeds, night and morning), of a mixture of equal parts of corn meal, wheat bran, and cotton-seed meal. "On August 10, the pastures having become dry, both lots began to receive a ration of green corn fodder of about 16 pounds per cow per day. On September 9 the corn fodder ration was changed to millet, which continued until October 1, when second growth grass was used; this continued until October 13, when pumpkin began to be fed." The grain feeding in this case resulted in a profitable increase in milk production and also in a considerable gain in weight of the cows. The beneficial effect of the grain feeding was observable the following season, particularly in the development and performance of the younger animals (2-year and 3-year olds).

At the Mississippi Station no benefit was derived from feeding 3 to 4 pounds of cotton-seed meal and 4 to 6 pounds of wheat bran per cow daily to cows running on good pasture.

The question of grain feeding of cows at pasture has recently been investigated anew by J. H. Stewart and H. Atwood of the West Virginia Station. They found that there was no direct financial gain from feeding 6 pounds per cow daily of a rather rich grain feed containing 16.5 per cent protein and 3.5 per cent of fat to cows on pasture, notwithstanding the fact that in some cases the pasture became short from drought. "It is true that the cows which received grain were uniformly in somewhat better flesh than those that did not receive grain, but as far as the milk yield was concerned the increased flow was produced at an actual loss."

Summarizing the results of all the experiments which have been made on the subject, the conclusion seems justified "that unless dairy products are especially high in price it is not a profitable practice to feed grain to cows at pasture. It is true that more milk is obtained and the cows hold up their yield better and remain in better flesh when receiving the grain rations, but under ordinary circumstances there is no direct profit from the grain feeding, as the increased production usually costs more than it can be sold for."

PRACTICAL USE OF STARTERS IN RIPENING CREAM.[a]

In recent years butter and cheese makers have more generally adopted methods of manufacture that involved the use of cultures of bacteria, commonly known as starters, for the production of desired characteristics of flavor, aroma, etc. Under these conditions constancy in results depends largely upon uniformity in the quality of the starters employed. Considerable use is made of commercial starters, the quality of which is quite permanent, but the expense for starters is a considerable item. The desirable organisms having been obtained, they may be used according to a method recently described by L. D. Bushnell and W. R. Wright in a bulletin of the Michigan Station, which is designed to insure a permanent quality of starters and at the same time to lessen the actual expenditure for them. The method as described is applicable to butter making, but it could be easily adapted for use by the cheese maker also.

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[a] Compiled from Michigan Sta. Bul. 246.

Some of the commercial starter usually employed is put into sterilized whole milk and allowed to develop there for twenty-four hours at a favorable temperature. For ease in manipulation the milk is sterilized in a quart bottle plugged with cotton. On the second day a portion of this milk is transferred to another bottle of sterile milk to continue the growth of the organisms, and the remainder is poured into a can of recently pasteurized skim milk. The latter is again kept for twenty-four hours at a temperature favorable to the growth of the organisms, and is then used as a starter for sweet cream. At the same time a portion of the second bottle of inoculated sterile milk, in which the organisms have been growing for twenty-four hours, is transferred to a third bottle of sterile milk, and the remainder of the second bottle used to inoculate another can of pasteurized skim milk for use as a starter on the following day. It is claimed that this method of growing the bacteria, if properly handled, will maintain a culture that will give uniform results for an indefinite period.

According to F. O. Foster, instructor in dairying at the Michigan Agricultural College, who has confirmed the application of the method to dairy practice, the advantages in it are as follows:

> The starter can be kept for a much longer period, thus saving one-half or more of the cost of pure cultures.
>
> The milk is always ready for inoculation and the mother starter can be transferred each day when in the best condition and kept vigorous.
>
> In case a starter is not needed every day, the mother starter can be carried along conveniently without the trouble of sterilizing milk.
>
> After a thorough trial we have adopted the method for our daily use. We find it no great task to sterilize the bottles of milk once or twice a month, and the little extra labor thus occasioned is more than offset by the convenience and sureness of the new method.

WATER PANS FOR POULTRY.[a]

Nothing is more important and few things are more difficult to insure than clean water for poultry. Ordinary receptacles and sources of water supply are as a rule quickly fouled and thus become breeders of disease. Poultry raisers generally recognize the importance of a watering device which will keep the water as free as possible from the dust and litter of the poultry house or yard and from the droppings of the fowls, and many forms of such devices have been devised. One that is simple in construction and has been found to be very satisfactory in use is described by J. E. Rice and R. C. Lawry in a bulletin of the New York Cornell Experiment Station. The construction of this watering pan is shown in figures 1, 2, and 3.

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[a] Compiled from New York Cornell Sta. Bul. 248.

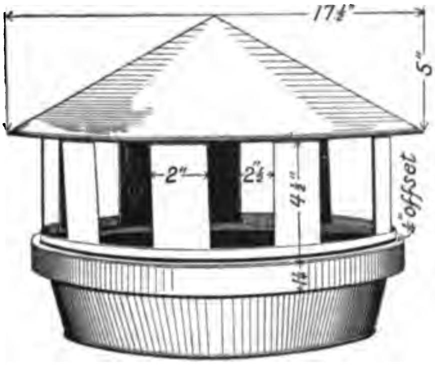

Fig. 1.—Sanitary water pan, showing the small space open for entrance of litter.

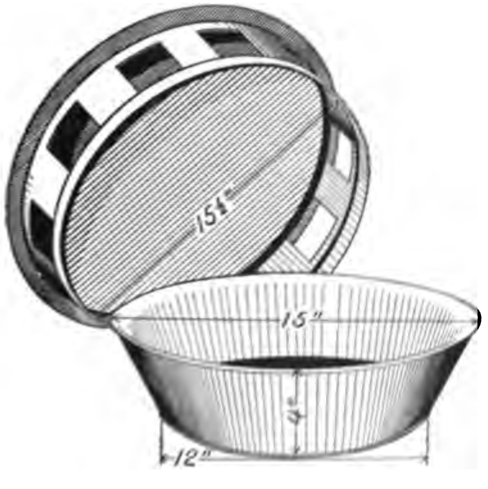

Fig. 2.—Sanitary water pan uncovered showing flanged rim of cover

The round, deep pan with flaring sides, is more easily emptied without injury to the pan in case of hard freezing. It presents a comparatively small surface to catch dust and dirt. The round, cone-shaped top prevents the fowls from roosting upon it. The openings in the side walls permit the fowls to drink from different sides at one time, and presents the smallest possible amount of opening for dust and litter to enter. The platform on which it stands, being 10 inches from the floor, is high enough to prevent the litter being scratched into it. It is found that when water pans are placed much higher than this, fowls do not drink as much water. The water pan and cover is made of No. 26 galvanized iron. It should not cost to exceed $1.40.

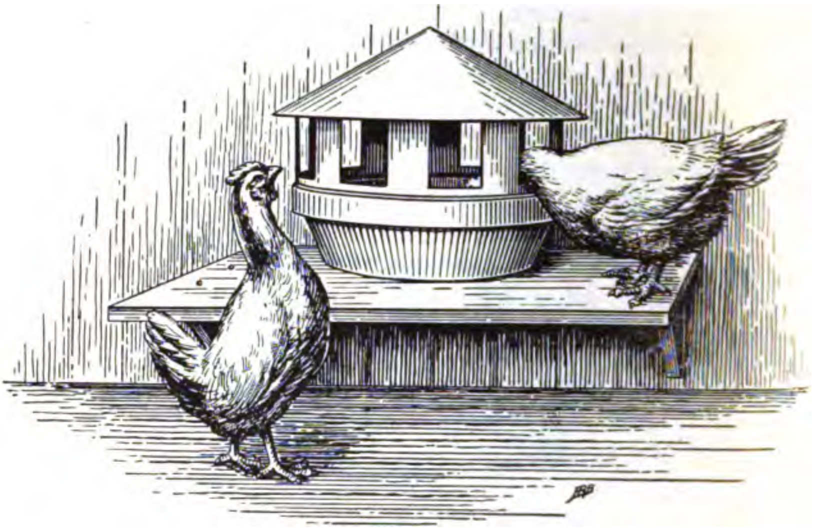

FIG. 3.—Sanitary water pan and cover in use on platform 10 inches above the floor.

Another form of water pan and "an inexpensive, handy, serviceable device" for keeping it clean is shown in figures 4 and 5. With this arrangement it is easy to empty or fill the pan, which should be placed on a slatted platform 10 inches above the floor and may be used to water either one or two pens.

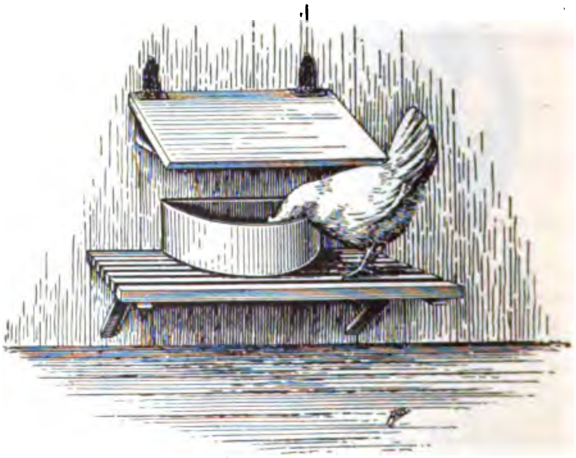

FIG. 4.—Water pan with cover lowered to prevent hens getting into the pan and the entrance of litter and dust.

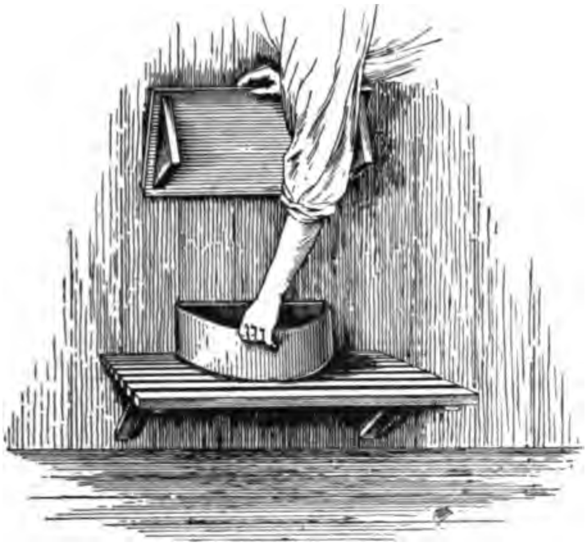

FIG. 5.—Cover raised for emptying or filling the pan. The water pan is arranged to supply two pens.

CATCHING HOOK FOR POULTRY.[a]

In a recent bulletin of the New York Cornell Experiment Station :. C. Lawry says: "Every poultry farm should have several catching ooks. They save time in catching fowls and prevent much of the :ight and injury which usually occurs on such occasions."

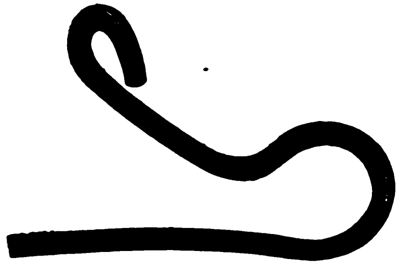

FIG. 6.—Catching hook, with wire turned back to avoid injury, wide open to catch quickly, and restricted clutch with enlarged hold.

He describes a catching hook which is an improvement of an old ıvention. The improvements described consist in so fortifying and racing the wire portion of the device that it remains practically rigid, nd in so shaping the hook end that the shank of the fowl may be ısily caught and effectively held without injury. The only materials required for the construction of the hook are a broom handle an 6-foot piece of No. 10 steel wire, which can easily be bent into proper shape. As figure 6 shows, the hook end should have a restric entrance which makes it difficult for the fowl to withdraw its sh but it should also have a large aperture which gives freedom of ac while the shank is held. Rigidity of the wire portion of the hook obtained by reinforcing it for a considerable part of its length fr the handle by a second piece of wire.

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[a] Compiled from New York Cornell Sta. Bul. 248.

In using the hook it will be found that the wire portion is less spicuous than the wooden handle and that the latter attracts fowl's attention while the shank is caught by the hook. The fowl then gently drawn from the flock, and the shape of the hook is that the foot may easily be released.

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Issued April 4, 1908.

U. S. DEPARTMENT OF AGRICULTURE.

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FARMERS' BULLETIN 318.

COWPEAS.

BY

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*Scientific Assistant, Forage Crop Investigations,
Bureau of Plant Industry.*

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1908.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., January 30, 1908.

Sir: I have the honor to transmit and to recommend for publication as a Farmers' Bulletin the accompanying manuscript on "Cowpeas," prepared by Mr. H. T. Nielsen, Scientific Assistant in Agronomy in Forage Crop Investigations.

The cowpea is the most valuable legume for the Southern States and its use would be much more extensive were it not for the relatively high price of the seed, most of which is still picked by hand. Particular attention is therefore given to the matter of harvesting seed by machinery now in very successful use in several communities. These methods are so far perfected that the cowpea seed crop should receive much greater attention in favorable localities.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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ILLUSTRATIONS.

FIG. 1. Cowpea plant (*Vigna unguiculata*), showing ripe pods
2. Field of Whippoorwill cowpeas planted in one-fifth-rod rows and cultivated three times
3. Field of Whippoorwill cowpeas broadcasted thickly
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6. A bunching attachment on an ordinary mower
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B. P. I.—343.

COWPEAS.

INTRODUCTION.

A system of agriculture without the use of a leguminous crop tends to lessen the productivity of the soil and makes necessary large outlays for nitrogenous fertilizers. With a leguminous crop grown at frequent intervals, the productivity may be maintained or even increased. The cowpea (fig. 1) is at the present time, and probably will continue to be, the most valuable legume for the entire cotton belt, and can be depended upon to succeed on practically all types of soils. It has been well said that the cowpea is to the South what red clover is to the North and alfalfa to the West.

It is safe to say that no one thing can add more to the agricultural wealth of the South than the more extensive growing of the cowpea. This will supply the southern markets with much of their hay, which is now shipped in from the North and West. It will tend to increase the production of live stock, which is very essential in securing the maximum returns in any system of agriculture; and it will go far toward keeping the soil in good tilth and maintaining its productiveness.

While cowpea culture has greatly increased in late years, this very fact has in part brought about a large increase in the price of seed. The more extensive use of the crop will be seriously retarded until seed becomes more plentiful than at present. Fortunately the development of improved machinery for handling cowpeas makes it certain that this will soon be the case and that the price of seed will be materially reduced without lessening the profit to the grower.

Cowpea seed for planting should be fresh and of good quality; or, if old, should be tested for germination, as seed more than one year old is likely to be very low in vitality. It is practically certain that seed which ripens and is harvested in dry weather is of superior quality. Varieties with hard seeds are injured to a less extent by wet weather at harvest time than those with soft seeds. They also retain their vitality for a longer time and are less subject to the ravages of weevils. The Iron cowpea is the only common variety which has any advantage over other sorts in this respect.

Good cowpea hay is fully as valuable a feed, pound for pound, as red clover hay, and very nearly equal in value to alfalfa or to wheat bran. The principal value of this hay lies in its high percentage of digestible protein, which is nearly four times that of timothy hay.

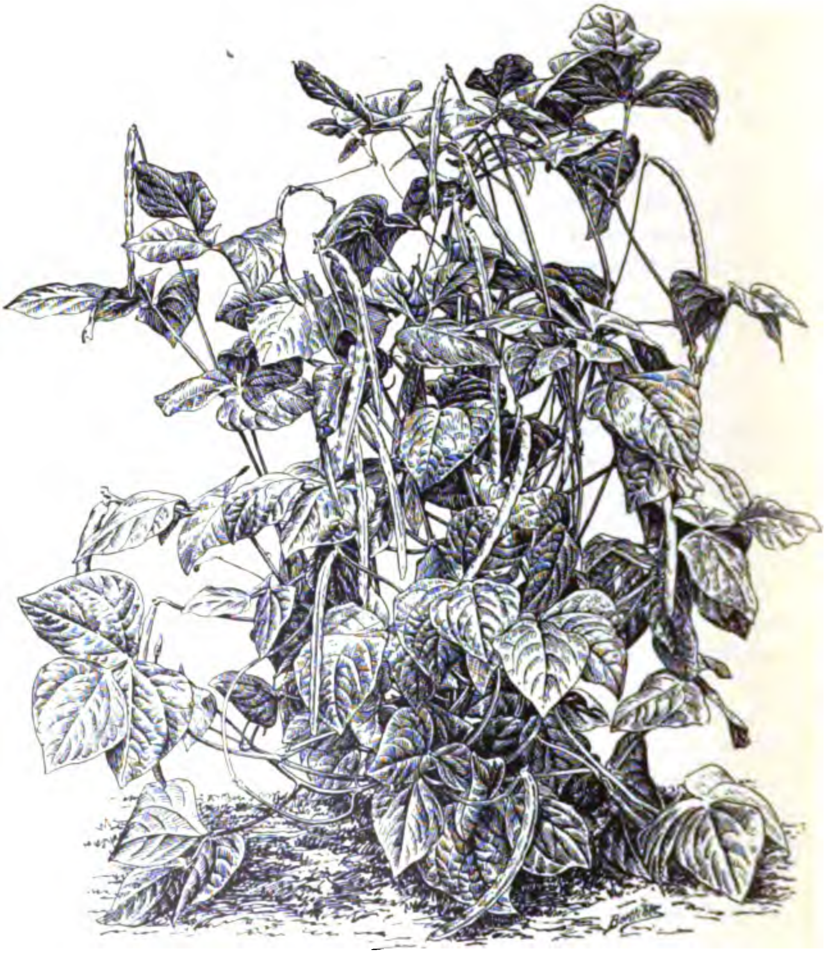

FIG. 1.—Cowpea plant (*Vigna unguiculata*), showing ripe pods.

One reason why cowpeas are not more extensively used as a hay crop is the difficulty often experienced in curing the large growth of succulent vines. Where proper care is taken in curing, especially where sorghum or a similar plant is grown with it in mixture, it is not a difficult matter to make good cowpea hay unless the weather is decidedly unfavorable.

When grown for hay production cowpeas are nearly always broadcasted or put in with a grain drill any time from May 15 to July 15. The quantity of seed used to the acre ranges from one to two bushels, broadcasting requiring from one-fourth to one-third more than is necessary when using a grain drill. The quantity most commonly used and which gives the most general satisfaction when the seed is put in with a grain drill is five pecks to the acre. The use of a grain drill is decidedly superior to broadcasting. Larger hay yields have frequently been secured by planting in rows 24 to 36 inches apart and giving two or three cultivations, the seed required in this way being from two to three pecks per acre. The increased yield of hay due to cultivation is not sufficient to cover the increased cost, especially as rather thick broadcast seeding is equally as effective in destroying weeds as cultivation in rows. The practice of broadcasting on small grain stubble and plowing under the seed is still common; also that of putting in the seed on grain stubble with a disk drill without plowing. Both of these practices are rapidly being replaced by good preparation of the soil before seeding.

As nearly as average conditions will permit, cowpeas for hay should be planted so that they will be at the proper stage for hay making in the latter part of August, in September, or early in October, as the rainfall is likely to be small during that time. With four to six days of dry sunny weather, cowpeas can be cured into hay of excellent quality if they are at the proper stage of maturity when cut.

The proper time to cut cowpeas for hay is when most of the pods are full grown and a considerable number of them are ripe. At this stage none of the best hay varieties have dropped their leaves. Of the large list of cowpea varieties, those with an upright habit of growth which seed fairly well and mature quite uniformly should be chosen for hay. The varieties more commonly used are Whippoorwill, Unknown, New Era, and Iron. These hold their leaves well and stand up much better than most of the other varieties. Such varieties as Black, Red Ripper, and Clay are not desirable for the production of hay, as they run to vine badly and are consequently very hard to cure and handle. The readiness with which the hay can be cured depends largely upon the maturity of the vine and the condition of the weather; hence the advisability of having the harvesting come when the season is most likely to be dry.

An ordinary mower is the most practical machine for cutting cowpeas for hay, and if an erect variety is grown the entire plant can readily be saved. The mowing should begin in the morning, as soon as the dew is off, and may be continued all day if desired, though some advocate cutting only till noon. The vines should be left in the swath until well wilted on top, but not till the leaves are dry and brittle. They should then be raked into windrows; this may be the same day or the day after mowing. They should be left in the windrows one or two days and then put into small cocks of one or two forkfuls. The cocks should be left till the vines are well cured, from two to five or six days, depending on the conditions which have prevailed during the curing period. A good rule to follow is that peas are ready for stacking or putting into the barn when it is not possible to wring moisture out of the stems by twisting a handful with considerable force.

The hay tedder can be used very advantageously in making cowpea hay. If the growth is very heavy the tedder should be used immediately after mowing, as it will open up the vines so the sun and air can get to them better. It can be used to good advantage on vines in the swath after the top part is wilted, as it opens them up so they will dry out more uniformly. It is also valuable for opening up the windrows a half day or a day before cocking. An ordinary rake can also be used for turning the windrows over. The tedder should never be used except when the vines are either green or damp, so as not to cause the loss of too many leaves.

In case of wet weather setting in shortly after mowing, the best practice is not to touch the vines at all until after the rain. It is a mistake to be in a hurry about handling after wet weather. If the vines are fairly mature before cutting, a wet spell during haymaking, unless prolonged, is not a very serious matter. If, however, the vines are immature when cut, great difficulty is always experienced in curing the hay in unfavorable weather.

Several special devices are more or less used in curing cowpea hay. The most common of these is a pole, usually with crosspieces nailed at right angles, around which the vines are cocked. Triangular pyramids from 2 to 3 feet high, built of poles with crosspieces nailed on to hold them together, are used to a small extent in the same way. The object of these devices is to get air into the vines by keeping them from becoming tightly packed together and to have an air space in the center of the cock. Canvas or other covers or hay caps, to protect the cocks during rainy weather, also have a limited use. These devices give excellent results in curing cowpeas, but on account of the increased cost and labor they entail are not in general use. A good and comparatively cheap hay cap would find a ready market and could be sold in large numbers. It would be a great help in cowpea hay making.

COWPEAS IN MIXTURES.

While cowpeas can be satisfactorily grown alone for hay, it is a much better practice as a rule to grow them in mixtures. The most widely used crop for this purpose is sorghum. This includes both the sweet sorghums and the kafirs. The sorghum serves to support the cowpea vines, and its use usually results in increasing the yield of hay considerably. An additional important advantage is that the hay is more easily cured, as the sorghum prevents the matting together of the cowpea plants. Corn is also used very extensively in mixture with cowpeas, but only to a small extent for hay purposes. The two are grown together very satisfactorily in cultivated rows. Other crops that have been used to grow in mixture with cowpeas are millet, soy beans, and Johnson grass.

Cowpeas and sorghum.—In the Piedmont region of the South a large percentage of the cowpeas planted for hay is in mixture with sorghum, and the practice should spread rapidly, as this mixed hay is very nearly a complete ration and is relished by all farm stock. The mixture has given excellent satisfaction on the Arlington Experimental Farm, near Washington, D. C. The variety of sweet sorghum most used is the Amber, as it is not as coarse as the others and hence cures more rapidly. The seeding is best done with a grain drill on well-prepared land, the two kinds of seed being well mixed and sown at the same time. The best rate is one bushel of good seed of cowpeas to one-half bushel of sorghum to the acre. If a grain drill is not available for seeding, the cowpea seed should be disked or plowed in, and the sorghum seed should then be sown while the land is rough, and covered with a drag harrow. The Whippoorwill, Iron, Unknown, and Clay cowpeas require about the same time as sorghum to mature and therefore should be used instead of the early varieties. In general, the planting may be done from June 1 to July 15.

Growing cowpeas and sorghum together in cultivated rows gives excellent results. They should be planted together in rows 2½ to 3½ feet apart, three pecks of cowpea seed and about one-third of a bushel of sorghum seed being used to the acre. The Sumac and the Orange varieties are fully as good as the Amber sorghum for this use, as they grow larger and stronger plants. The harvesting is most satisfactorily done with a mower.

Cowpeas and corn.—Cowpeas are most widely used at present for growing with corn. When grown in this way a farmer secures a crop of corn, sufficient cowpea seed for use the next season, and either a hay crop or a certain amount of grazing for his stock. The cowpea is an excellent plant to grow with corn for ensilage, and is being used quite extensively for this purpose on many dairy farms, especially in the northern part of the cowpea region. When planted in the cornfield it is usually at the last cultivation of that crop. The quantity of seed used to the acre ranges from a half bushel or less to two bushels, depending largely on whether the planting is broadcast or in rows close to the corn. Generally the best results are obtained by the use of about three pecks of seed and planting near the rows of corn, preferably with a corn, cotton, or other planter, immediately after the last cultivation of the corn. Usually the peas are allowed to ripen a fair percentage of pods, which are gathered for next year's seed, and the vines are then pastured.

In the sugar-cane districts of Louisiana and in parts of Mississippi and Alabama the cowpeas are made into hay instead of being pastured after the corn has been gathered. This is a very good practice and is becoming general. The work is very satisfactorily done with a strong wooden-toothed rake, which pulls the vines and leaves them in small bunches for curing. The harvesting is also done with a mower to some extent.

In a few localities, especially in parts of Maryland, corn and cowpeas are sown thickly together for hay with excellent results. The seeding for this purpose is at the rate of one-half to one bushel of corn and one bushel of cowpeas to the acre. The two mature at practically the same time, the yield is large, and the curing is easily done.

Cowpeas and Johnson grass.—Where Johnson grass is not a pest or where it is well established on a field and there is no desire to clean it out, it can very satisfactorily form a part of a mixture with cowpeas. At the Arlington Experimental Farm in 1906 the mixtures of Johnson grass and cowpeas gave the best results both in yield and in the quality of the hay produced. There is no difficulty in killing out Johnson grass north of Tennessee and central Virginia, but south of these States the difficulty increases rapidly.

The mixture should be sown at the rate of one bushel of Johnson grass and one bushel of cowpeas to the acre; if the seeding is done with a grain drill, care must be exercised not to cover the Johnson grass seed too deeply. Where this grass is already established, the land may either be plowed or thoroughly disked in late spring, the treatment depending on the nature of the soil, and then the cowpeas alone should be sown in June. One and a half bushels of cowpea seed to the acre are frequently used, as the Johnson grass makes a more vigorous growth under such circumstances than when coming from seed. This latter practice is common at Augusta, Ga., and gives excellent results. The quality of hay obtained is very good and it is not as coarse as the mixture with sorghum. The fact that Johnson grass often becomes a troublesome weed is the only objection to it in mixture with cowpeas for hay production. In other respects it is the best plant for this purpose.

Cowpeas and millet.—German millet has often been grown in mixture with cowpeas. As it matures in a relatively short time it is adapted for growing only with the early varieties of cowpeas, such as the New Era, and even with these the yield is rarely increased. The millet aids materially in curing the hay, however, and possibly improves its quality by adding variety. Millet should never be used in mixture with the late and rank-growing cowpeas, as the results obtained are not satisfactory, since in addition to maturing too early the millet is not strong enough to hold up the cowpea vines.

Cowpeas and soy beans.—But little experimenting has been done in growing soy beans and cowpeas together, but the results obtained have been very promising. Only the larger-growing soy beans, such as the Mammoth variety, are suitable for this use. The soy beans are strong enough to assist very materially in holding up the cowpeas, and they also aid effectively in curing the hay. The combination is therefore worthy of much more extended use. The hay of this mixture is an exceedingly rich one, as the composition of both plants is high in protein. Seeding should be at the rate of a bushel of soy beans and a half bushel of cowpeas to the acre.

COWPEAS FOR PASTURE.

The use of cowpeas for pasture is not as a rule the best farm practice, but under certain circumstances it is advisable and fairly profitable. Grazing cultivated lands is likely to render succeeding tillage more difficult on account of the trampling by stock; and, unless care is exercised in pasturing cowpeas, loss of animals by bloating may result, especially in wet weather. However, the small amount of work and the insignificant cash outlay always associated with the grazing of stock commend the practice to the average farmer, and scarcity of labor often makes it necessary to pasture a crop whenever possible. Cowpeas when planted in corn are very commonly used for grazing, especially with hogs.

The best time to begin pasturing cowpeas is when the first pods are ripe. This practice is not generally followed, as at least a part of the seed is saved first. When the peas are grown in cornfields the grazing is deferred until the corn has been gathered.

In a feeding trial at the Alabama Agricultural Experiment Station it was found that pigs fed corn alone gained 0.36 pound daily, while pigs on cowpea pasture and corn gained 0.97 pound daily, consuming 36 per cent less corn for each pound of gain. The returns were $10.65 for an acre of cowpeas, with corn at 40 cents a bushel and hogs at 3 cents a pound.

The Oklahoma Agricultural Experiment Station reports that cow-peas planted early in July furnished two grazing periods for milk cows before frost in the fall and that the flow of milk was noticeably increased. At the Arkansas Station steers were fattened on cow-pea pasture and cotton seed, making an average gain of 2 pounds a day for ninety days. So long as the pea vines were green and considerable seed was available, very little cotton seed was eaten. The cost of each pound of gain was only 2 cents for the cotton seed, thus showing the high value of the cowpea pasture.

FEEDING VALUE OF COWPEAS.

Cowpea hay.—The feeding value of cowpea hay has long been recognized, as it has been used extensively for all kinds of stock in the Southern States. With a fair number of ripe peas in the hay it has been found to be satisfactory when fed alone to stock at work, and can be used very successfully as a maintenance ration for horses, mules, cattle, sheep, and even hogs. The farmers in the sugar-cane districts of Louisiana make a very extensive use of cow-pea hay for their work stock, it being practically the only roughage used. It is generally claimed that horses or mules at work stand hot weather better when fed cowpea hay than when fed a grass hay and corn. The difference in the appearance of the animals is also very much in favor of the cowpeas.

In a three months' test at the North Carolina Agricultural Experiment Station the rations fed two high-grade Percheron mares, used as a team and receiving the same care and shelter, differed only in the use of 10 pounds of cowpea hay in one and the same quantity of wheat bran in the other. The horse fed bran just held its own in weight while the one fed cowpea hay gained a little. The cowpea ration was 5 cents cheaper in daily cost.

At the Arkansas Agricultural Experiment Station two three-year-old steers were fattened on cowpea hay and cotton seed in a feeding trial lasting ninety days. The daily ration consisted of 13 pounds of cotton seed and 20 pounds of pea hay. The average daily gain was 3 pounds for each steer, and the cattle were in excellent condition during the entire trial. The profit realized was $21.30. The Tennessee Agricultural Experiment Station found that 6 to 10 pounds of cowpea hay could be substituted for 3 to 5 pounds of cotton-seed meal in beef production. This indicates that this hay can be utilized to advantage in place of corn and cotton-seed meal when these feeds are high priced.

In the production of milk and butter, the Tennessee Agricultural Experiment Station reports that 1½ pounds of chopped pea hay is equivalent to a pound of wheat bran, and 3 pounds of chopped pea hay to a pound of cotton-seed meal. With bran valued at $20 a ton a yield of 2½ tons of cowpea hay would mean a return of $40 an acre for the crop, based on its feeding value. Cowpea hay is equally as good as bran for producing a flow of milk.

Cowpea seed.—The seed of cowpeas is rarely obtainable at a low enough price to be used as a feed. Its composition indicates that it is a richer feed than wheat bran. The Alabama Agricultural Experiment Station fed cowpeas to fattening pigs with excellent results. More lean meat was found in the bodies of the pigs fed cowpeas than in those fed corn meal only. A great many people have tried feeding the seed, either whole or in broken pieces, to poultry. Splendid results are obtained, the fowls being kept in good condition and producing a good supply of eggs, even in the winter months. Very good results are also obtained by feeding the hay, as the fowls eat all except the hard, coarse stems.

Cowpea straw.—Now that cowpea seed can be secured by running the vines through a thrashing machine the straw is coming to be quite an important feed. While no authentic data are at hand in regard to this straw, farmers and stable keepers who have used it claim that it is an excellent feed, some even preferring it to ordinary pea-vine hay. There have been no ill effects reported from its use. The straw sells for about the same price as the hay.

GROWING COWPEAS FOR SEED.

The greater agricultural use of cowpeas has been seriously handicapped in late years by the high price of seed. Until the last few years cowpea seed has been almost entirely gathered by hand, though that harvested by machinery makes up an increasing percentage of the commercial seed each year. Cheaper seed will undoubtedly bring about an enormous increase in the culture of the crop.

Cowpeas when grown for seed or for combined seed and hay production are nearly always sown broadcast or with a grain drill. Occasionally fields are planted in rows and cultivated. Experiments generally prove that the largest yields are secured by planting in rows and cultivating, but in many localities this increased yield is not sufficient to offset the additional cost of cultivation.

The planting of cowpeas for seed production should always be thinner than for forage purposes. Figure 2 shows a field of cowpeas of the Whippoorwill variety planted in rows one-fifth rod (about 3 feet 4 inches) apart and cultivated three times, while figure 3 shows a field of the same variety broadcasted thickly. Attention is called to the fair crop of pods and the larger size of the plants in the cultivated area. Figure 4 shows a field of Iron cowpeas planted in rows one-fifth rod apart and cultivated three times. The plants are much larger than those shown in figure 5, a field of the same variety broadcasted thinly; but the plants in both fields are well podded. When grown in rows 24 to 36 inches apart one peck to a half bushel of good seed per acre is required. When the seed is broadcasted the quantity ranges from 3 to 6 pecks to the acre, depending on the soil, the method of seeding, and the size of seed. Heavy clay or light sandy soils require more seed than loam soils. If sown with a grain drill only about two-thirds as much as for broadcasting is required. Of the smaller seeded varieties, such as the New Era and the Iron, 2 or 3 pecks will give the best results; while of the larger seeded varieties, such as the Black, the Unknown, and the Whippoorwill, the quantities range from 3 pecks to 5 pecks to the acre, a bushel generally being the best amount to use. In most of the cowpea region planting for seed production should be rather late in the season, since late plantings as a rule give much better seed yields than early plantings. This is not the case, however, in Oklahoma and northern Texas, where early seeding gives the best yields, owing probably to the lighter rainfall. In certain sections near the Gulf, two seed crops in a season may be secured by growing in rows and planting the first very early.

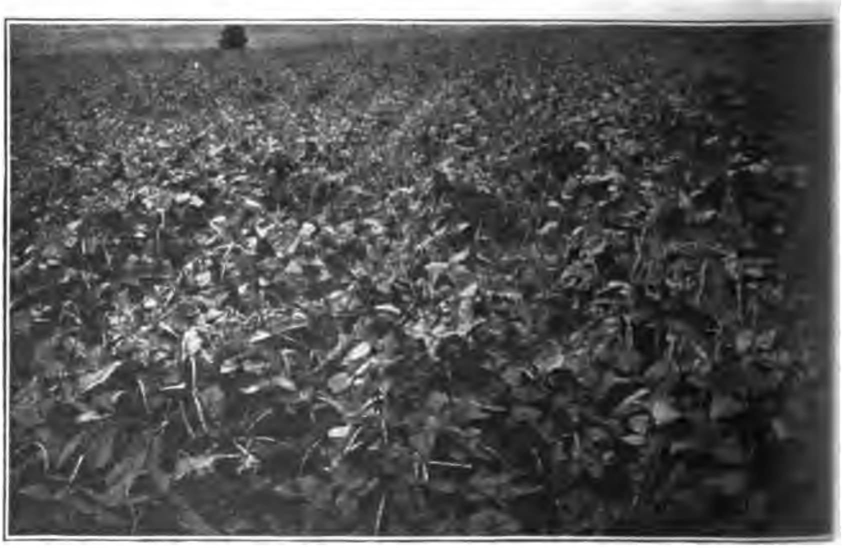

FIG. 2.—Field of Whippoorwill cowpeas planted in one-fifth-rod rows and cultivated three times.

HAND PICKING.

The method of gathering seed by hand is the only one practicable where the peas are planted in corn, which is a very common practice throughout the South. The cowpeas are planted at the last cultivation of the corn and are nearly always ripe before frost. The vines climb the corn stalks, so most of the pods are well above ground, which greatly facilitates gathering them. They are picked by hand into bags, and later flailed or run through a pod huller. The cost of hand picking ranges from 40 to 75 cents a hundred pounds of pods, or the picker is given one-third to one-half of the total quantity gathered. This method of harvesting naturally makes the price of seed high. Fields grown to cowpeas alone for seed production are often hand picked. The yield of seed in such cases is as a rule much larger, and a larger number of pods can be picked in a day than when grown with corn. The Blackeye and similar varieties grown for table use are usually picked by hand.

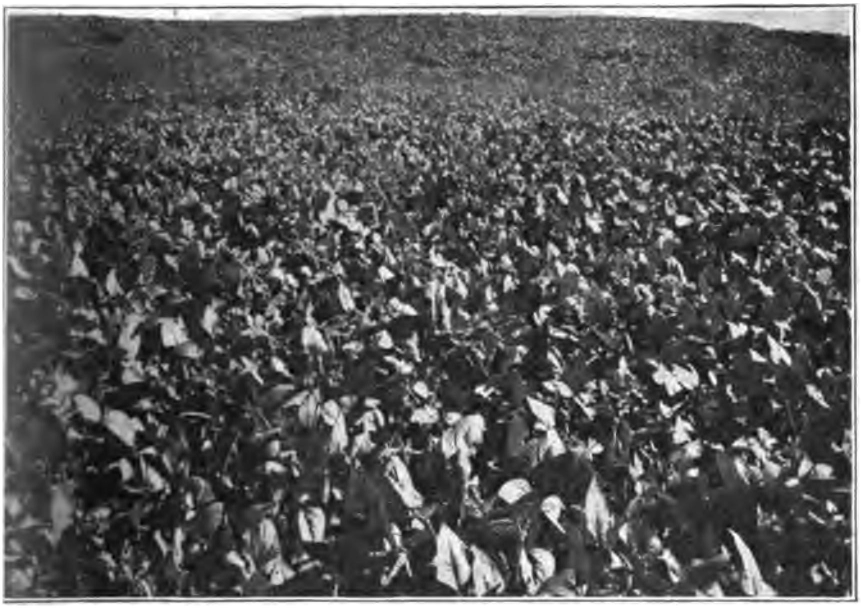

FIG. 3.—Field of Whippoorwill cowpeas broadcasted thickly.

MACHINE PICKING.

The scarcity of seed and the difficulty of securing labor have resulted in the invention of several so-called pea pickers. These machines are intended to gather the pods from the vines in the field. The peas must be planted in rows for the most successful operation of a pea picker, and the entire plant must be ripe and dry before the machine will do satisfactory work. Two of these pickers are constructed on much the same principle, that of a winged drum revolving rapidly over a stationary moderately sharp edge. The pods are thus knocked back upon a platform and then elevated into a receiving box or bag. A third machine differs from the foregoing in that the picking apparatus is very much in the nature of a flailing operation, the cylinder consisting of four arms made up of pieces of gas pip This revolves rapidly and knocks the pods back into the gatheri

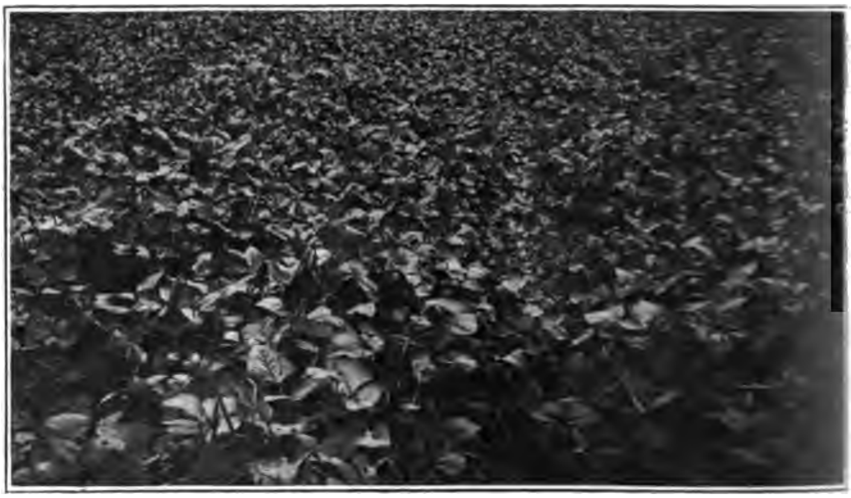

FIG. 4.—Field of Iron cowpeas planted in one-fifth-rod rows and cultivated three tim

box. A fourth machine is a harvester and thrasher combined. I this, the vines are cut with an ordinary mowing arrangement a

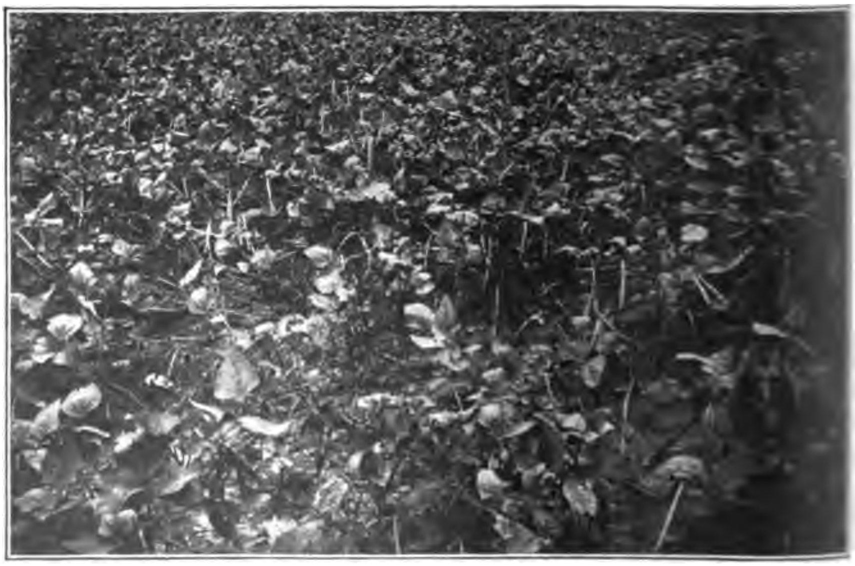

FIG. 5.—Field of Iron cowpeas broadcasted thinly.

passed directly to the thrashing part of the machine, which is essentially the same as that of any thrasher. This last-mentioned machine is very satisfactory for harvesting perfectly ripe peas, since it very nearly completes the operation. For harvesting varieties grown for table use, such as the Blackeye, the Lady, and other white peas, it may find considerable demand.

MOWING AND THRASHING.

Cowpeas for seed production are quite satisfactorily harvested with a mower. A bunching attachment (fig. 6) has been used with excellent results. This gets the vines out of the way of the team, thus avoiding considerable loss of peas through trampling and crushing by the mower wheels. It also leaves the vines in a more desirable shape for curing, they being rolled into small windrows. The self-rake reaper (fig. 7) is a very satisfactory machine for mowing cowpeas for seed, accomplishing even better results than the buncher on a mower, as the vines are left in bunches of very convenient size for curing and handling.

The bean harvester has been given careful trial in harvesting cowpeas for seed production, but it is not very satisfactory. Viny peas catch on parts of the machine and drag badly. There is also likely to be much soil worked into the vines, making the further handling difficult and disagreeable. The accompanying illustration (fig. 8) shows a bean harvester at work.

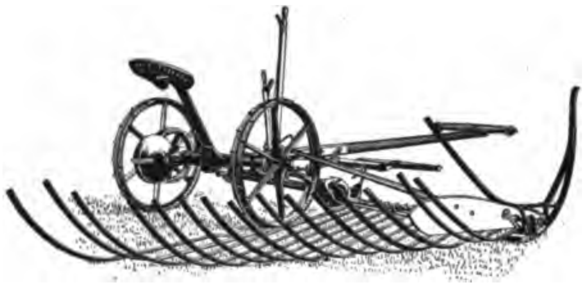

FIG. 6.—A bunching attachment on an ordinary mower.

For seed production cowpeas should be allowed to mature a greater percentage of pods than when cut for hay. Half or more should be ripe before mowing, even at the expense of losing a part of the foliage. The vines should then be allowed to cure and become thoroughly dry, after which the thrashing may be done. The curing and drying may be done in the swath, cock, stack, or barn, as desired, weather conditions largely determining the method to be pursued. The hay or straw is of better quality if the curing and drying are done in the stack or barn, though, of course, the amount of work required is greater. It is a common belief that weevils do much less damage to seeds in the pods than to the thrashed seeds. On this account some growers store their crop and thrash it late in the winter or early in the spring. However, the unthrashed material requires much space for storage, and there is no effective way of combating the insects, while in clean stored seed all inse life is readily destroyed by treatment with carbon bisulphid.[a]

Cowpeas may be thrashed with an ordinary grain thrasher. In this case the riddles are adjusted for cowpeas and satisfactory screens are provided. The most essential point in thrashing cowpeas is to maintain a low and even speed of the cylinder, 300 to 4 revolutions per minute, while the rest of the machine should b adjusted to run at least as fast as for thrashing wheat or oats. Some operators prefer to have a greater clearance between the cylinder and concave spikes than for grain thrashing, while others do n think this an advantage. While expert operators sometimes do very satisfactory work with an ordinary grain separator, there are thre important difficulties encountered: (1) Too many of the pods pas through with the straw unopened; (2) the machine is easily choked by the tangled vines wrapping around the cylinder; and (3) the percentage of cracked peas is usually large.

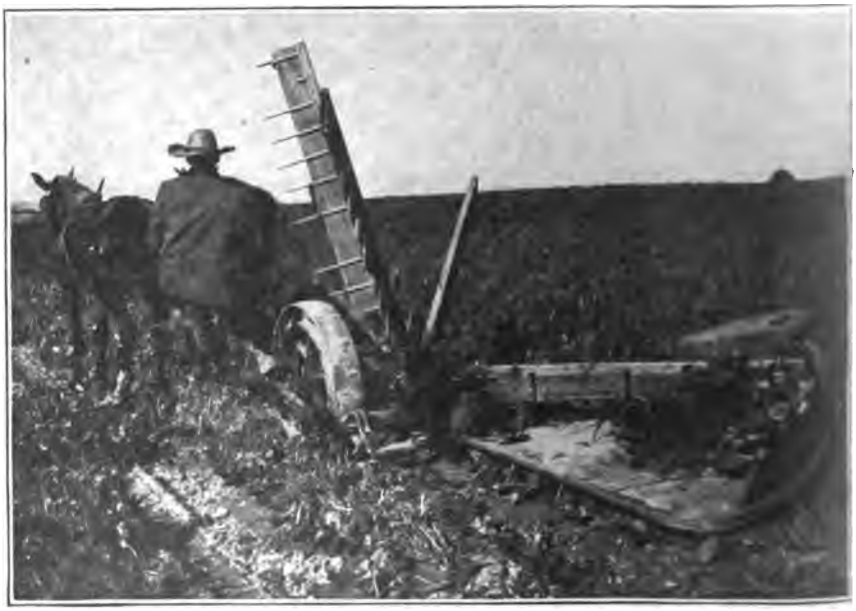

FIG. 7.—Harvesting cowpeas for seed with a self-rake reaper.

To overcome these difficulties several modifications of thrashing machines have been devised so as to adapt them for handling cowpeas. One modification which has been adopted in several different machines is the use of two cylinders. These cylinders are adjusted to run at different speeds, the front one slowly, about 300 revolutions per minute, and the rear one more rapidly, about 450 revolutions per minute. Apparently the only advantage gained by two cylinders over one is that a smaller percentage of the unopened pods pass through with the straw. The use of two cylinders, however, results in a somewhat larger percentage of cracked peas.

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[a] For destroying weevils or preventing damage by them, see article o "Insects Injurious to Beans and Peas," in the Yearbook of the Department of Agriculture for 1898.

A second modification which has been applied both to machines with one cylinder and those with two is to sharpen the spikes on the concaves or on both the concaves and cylinders. This sharpening means bringing the face of the spike to as nearly a sharp edge as can be done by ordinary blacksmithing. The beneficial effect of sharpening the spikes is very marked, as the vines pass through much more readily, there is little tendency to wrap around the cylinder, the amount of power required is very materially reduced, and the percentage of cracked peas is decidedly smaller. The straw is also chopped so it is in fine condition for feeding. A one-cylinder machine with the spikes sharpened does very satisfactory work except that a small percentage of the pods may pass through in the straw unopened, while by the use of a two-cylinder machine practically all the peas are secured.

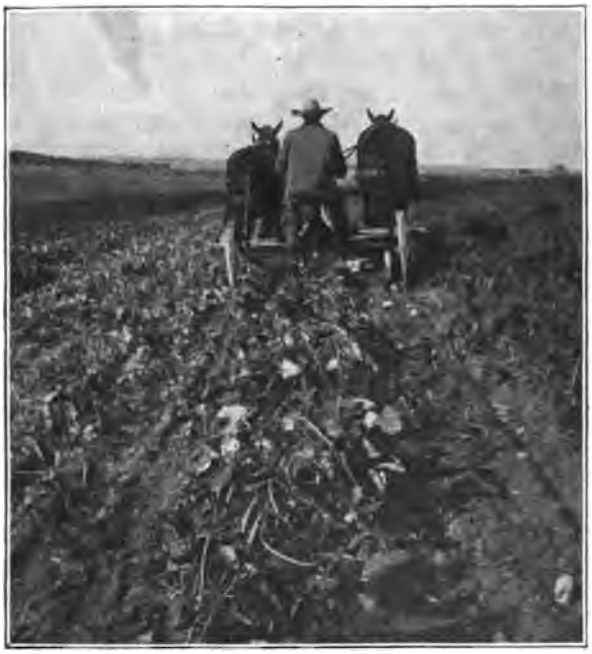

FIG. 8.—Harvesting cowpeas for seed with a bean harvester.

In a third device all the spikes in both cylinder and concaves are sharpened, and there is a minimum of clearance. The concaves are arranged in two sets, one of two rows and the other of three. The two-row set is at the front of the cylinder on a plane with the shaft; the other is below the cylinder and at the back of it about 120° from the first. There is a perforated web under the cylinder which is hinged at the three-row set of concaves and has the front part attached to the shakers so that it is worked up and down by their backward and forward motion. When the vines come through the first concaves they drop on the web, rest momentarily, and are then picked up by the cylinder again and taken through the second concaves. This momentary rest results in the rearrangement of the straw, so that it virtually amounts to passing through a second cylinder, as in the two-cylinder machines. A perforated feeding table is used to get loose peas to the separating surface without passing through the cylinder. This machine is by far the most satisfactory pea thrasher yet devised. The number of cracked peas is very small; the vines are chopped as fine as if they had been through a cutting box, and all the peas are gotten out of the pods, while the material which can be run through in a given time is the maximum for present-day machines and the power required the minimum.

It is very essential in thrashing cowpeas that there be sufficient power to give a uniform speed to the separator. It is also highly desirable that the cylinder be kept uniformly full in order to get the best results, as running empty means an increase in the number of cracked peas.

The price of cowpea thrashers now on the market ranges from $300 to $600, exclusive of the engine. If the peas are stacked or put into a barn so they need not be thrashed immediately, one machine will be sufficient for 2,000 acres, as the crop from 20 acres can readily be handled in one day. As a rule only a moderate acreage of cowpeas for seed should be grown by any one farmer, as unfavorable weather may cause great difficulty at harvest time. It is very desirable to have enough cowpeas for seed grown in a community to justify the local ownership of a thrashing machine.

COWPEAS FOR SOIL IMPROVEMENT.

The beneficial results of growing cowpeas are due largely to the ability of the plants, like those of alfalfa and red clover, to take nitrogen from the air by means of the bacteria which live in the nodules on the roots. Cowpeas also improve markedly the physical condition of the soil. This, taken in connection with their ability to produce a crop quickly on even the poorer soils, makes the cowpea particularly valuable both as a catch crop and in regular rotations when utilized either for hay or seed production.

At the present time the most popular rotation for the entire South is one which allows the largest possible area to be planted in cotton each year. A system of cropping which is in general use is three years in cotton, the fourth year in corn and cowpeas, and then three years in cotton again. This system allows three-fourths of the farm to be in cotton each year, and is applicable to all of the better agricultural land. On the poorer soils of the cotton belt it is likely that better results would be secured by growing cotton only two years and corn and cowpeas the third year. This would leave two-thirds of the farm for cotton each year, and would undoubtedly be an excellent system of cropping. The Alabama Agricultural Experiment Station reports an increase in yield in one case of 696 pounds of seed cotton to the acre, or 83 per cent, due to plowing under a crop of cowpea vines on land which had been in cotton the previous season. The Arkansas Agricultural Experiment Station secured an increase in yield of 59 per cent where a crop of cowpeas had been grazed the preceding year.

Practically the same plan of rotation is followed in the sugar-cane districts of Louisiana. Three crops of cane are taken off the land, and the fourth year it is planted to cowpeas or to corn and cowpeas. The work stock are fed almost exclusively on pea-vine hay or are grazed on cowpeas in the cornfield after the corn has been gathered. This rotation gives excellent results in the succeeding crops of cane.

A rotation of wheat or oats and cowpeas is giving excellent results in parts of Missouri, Arkansas, and Tennessee. Cowpeas are sown on the land immediately after the removal of the grain crop and are utilized for hay or seed or for pasture. Grain is sown again in the fall, thus making two crops a year from the same land. In many instances landowners in Arkansas and Missouri have allowed tenants the use of land free of charge for producing a crop of cowpeas, stipulating, however, that the land must be well prepared. When the soil is given good preparation before sowing the cowpeas, it is not necessary to plow in the autumn for the grain. The fall preparation usually consists of disking the cowpea stubble and sowing the grain with a drill. Occasionally the seeding is done with a disk drill without any preliminary preparation. The increase in yield of wheat due to the cowpeas is generally given as from 3 to 5 bushels per acre. At the Missouri Agricultural Experiment Station, an increase in yield of 63 per cent with oats and 49 per cent with wheat following cowpeas as a catch crop was secured. The Arkansas Agricultural Experiment Station reports as the average of a four years' test on wheat an increase of 25 per cent from plowing under cowpea stubble the first fall, 39 per cent from plowing under cowpea vines, and 42 per cent where cowpeas were grown each year as a catch crop between the wheat crops, only the stubble of the peas being plowed under. The increased yield in the latter case amounted to 70 per cent in the fourth season, the yields having gradually increased from year to year, in addition to producing a fair quantity of very nutritious hay each season.

On farms where more or less live stock is produced the following three-year rotation is very popular and is a good one: First year, cotton; second year, corn with cowpeas at last cultivation: thir year, winter oats or wheat, with a catch crop of cowpeas for hay o seed after the grain has been removed.

A few striking results due to the growing of cowpeas are her noted. The Alabama Agricultural Experiment Station report yield of oats following cowpea vines plowed under 247 per ce larger than where German millet was plowed under. The Arkans station reports an increase in yield of 63 per cent on corn where cow peas were grazed the season before. The Missouri station increas the yield of corn 79 per cent by growing cowpeas on the land for tw years before planting the corn. In yield of hay the Arkansas statio secured an increase of 116 per cent on oats following cowpeas graz the year before. The Alabama station increased the yield o sorghum hay 2.01 tons, or 55 per cent, by plowing under cowp stubble on land where sorghum was grown the previous year.

These and many similar experiments conclusively prove that it i much more economical to use cowpeas for hay or seed production i rotation with other farm crops than to use them for green manuring. It is only in special cases that it is advisable to utilize cowpe as a green manure. On very poor sandy land or on stiff, heav clay soils in bad mechanical condition a crop of cowpeas plowed under will give markedly beneficial results. Cowpeas give very go satisfaction as a cover crop in orchards, for which they find a limite use. In case of bad weather setting in at harvest time it may b desirable to utilize the crop for green manure, or to pasture it if t land is of such a nature as not to be seriously injured by the trampling of stock.

VARIETIES OF COWPEAS.

There are about 50 varieties of cowpeas known, but only a few o the best of these are extensively cultivated. The varieties differ i such characters as habit, size, earliness, prolificness, disease resistanc and especially in the color of the seeds, which are either entirely whi red, buff, black, or blue, or variously blotched or speckled. The varieties are all very constant in their seed characters. The variation i vines, however, is very marked, being influenced by the time of planting, the nature of the season, and the locality where grown. Ear planting or a wet season usually results in a large growth of vin Natural crosses between the varieties occur under favoring conditions, but they are far from common. The use to be made of t crop by the grower should determine largely which variety to sele

For table use the varieties with white or nearly white seeds ar preferred, as they make a more attractive dish. The habit of growt of the table peas is of little direct concern, and, as a matter of fac none of them is very satisfactory for forage purposes. The pri cipal varieties are the Blackeye, of which there are several strains, the Browneye, the Lady, and the Cream. These are more properly considered vegetables. Several of the colored-seeded varieties are also used as table peas.

For forage purposes the most desirable varieties are those which have a fairly upright habit, grow to large size, hold their leaves well, and produce an abundance of pods. Descriptions of the most important varieties follow. Of the numerous remaining varieties none is grown to a very large extent, and most of them are distinctly inferior to those described here.

Whippoorwill.—The Whippoorwill variety is known under several other names, such as Running Speckled, Bunch Speckled, and Shinney. It may be considered the standard of all field cowpeas. It is suitable either for grain or hay production, or both. It makes a vigorous growth, is fairly erect, and still produces a large amount of vine. It can readily be handled by machinery, which is bringing it more and more into prominence. The seed is mottled chocolate on a buff or reddish ground color.

Unknown, or Wonderful.—The Unknown, or Wonderful, cowpea is another field variety which is grown to a large extent. It is the largest growing and most vigorous of the cowpeas, but is late in maturing, it being difficult sometimes to secure seed of it as far north as Washington, D. C. The principal objection to this pea is its light seeding. It is nearly as erect as the Whippoorwill variety; hence, it is quite readily handled by machinery either for grain or hay production. The seed is large in size and of a very light clay color.

New Era.—The New Era is the smallest seeded of the cowpeas that have found a wide use. The seed is bluish in color, owing to the innumerable minute blue specks on a gray ground. The New Era is the most nearly erect of any of the varieties, rarely having any prostrate branches. It usually produces a heavy crop of seed and matures in from seventy-five to ninety days. It is one of the earliest of the cowpeas and is the most easily handled by machinery. The small seed is not usually considered an undesirable character, as a smaller quantity is required for seeding than is the case with other varieties.

Groit.—The variety known as the Groit has been much confused with the New Era cowpea. In habit the two are much alike, but the Groit is a little superior, as it makes a larger growth and fruits more heavily. The seed is quite similar to that of the New Era, but has chocolate mottlings in addition to the blue specks. It is quite certainly a hybrid between the New Era and the Whippoorwill varieties.

Iron.—The Iron variety is coming rapidly into prominence. In its habit it is only slightly different from the Unknown, though it is not quite as vigorous or as large. It is earlier than the Unknown and the seed, though nearly the same color, is much smaller, being but very little larger than that of the New Era. The characteristic of the Iron cowpea which has been instrumental in bringing it into prominence is its resistance to wilt and to root-knot caused by eel worms. It is the only one of the cowpeas which has been found to resist these diseases. Where they are prevalent in the soil, the Iron cowpea is the only variety which can be successfully grown, and since the diseases are spreading the distribution of the Iron cowpea is also increasing. Regardless of its resistance to these diseases it is a valuable variety under nearly all conditions, being vigorous, prolific, and quite erect. The seed is hard and retains its vitality better than that of most varieties. It will lie in the ground through the winter and germinate the next spring. This variety and the Unknown hold their leaves better than any others.

Clay.—The Clay cowpea is more variable in its habit than any of the foregoing varieties. It is the most pronounced trailer of any of the peas grown quite largely, and is consequently in very slight favor where the pea crop is handled by machinery. The plants are very vigorous but low growing, and they usually seed sparingly. Since seed is such an important item at the present time, a variety which has but poor fruiting qualities is not apt to remain popular, even though it may be harvested readily by machinery. The seed is of the same color as that of the Unknown and the Iron, but is intermediate in size and flatter and longer.

Black.—The Black cowpea is used to a considerable extent in the sandy coastal plain soils of Virginia and North Carolina. On heavy clay land this variety makes a very heavy growth of vine, but produces very little seed, while on the sandy lands it grows more bushy and fruits quite heavily. It also finds some demand in the sugar cane section of Louisiana, where it is grown with corn in rotation with sugar cane. Where other varieties thrive the Black is not a favorite. The seeds are quite large and entirely black.

Taylor.—The variety called Taylor has larger seeds than any other cowpea. The seeds have nearly the same markings as those of the New Era, though the ground color is somewhat lighter. The Taylor cowpea has met with considerable favor in Maryland and Delaware, where it is erroneously called the Gray Crowder, but outside of this region does not seem to be a very valuable variety. In most cases it is too much of a trailer to be desirable. It also has a tendency to drop its leaves earlier than any of the other varieties except the Black.

Red Ripper.—The Red Ripper is a valuable pea, as it makes nearly as large a growth as the Unknown, or Wonderful, and is excellent for growing in corn. It is very late, usually maturing but a small number of peas at Washington, D. C. It is difficult to procure seed of it in quantity on account of its light yield. The seed is dark red and about the same size as that of the Whippoorwill variety.

SUMMARY.

(1) The cowpea is the best legume for the entire cotton belt, and can be profitably grown much farther north. It is especially suitable for combined hay and seed production or for hay alone.

(2) To make good cowpea hay requires careful handling of the crop. The plant should have made its growth and have at least the first pods ripe when the mowing is done. Uniformity in maturing is essential in getting the best results. The use of a tedder is very helpful. The serious loss of leaves can be avoided by not handling the hay when the leaves are dry and brittle. The curing is best done in small cocks, and the hay is ready for the stack or barn when no moisture can be wrung from the stem by twisting it with considerable force.

(3) Cowpeas for hay production are very advantageously grown in mixture with sorghum, Johnson grass, or soy beans. The yield is thus increased, the quality improved, and the curing more easily done. Cowpeas give very good results when grown with sorghum in cultivated rows and are very commonly planted in corn and used for grazing or ensilage.

(4) Pasturing cowpeas is not the most economical practice, but it is frequently resorted to because of the small expense it entails. Cowpeas are especially suitable for grazing hogs.

(5) Cowpea hay is very nutritious. It is nearly equal to wheat bran as part of a ration. It is satisfactory for work stock and for beef or milk production, and it gives good results when fed to poultry. The grain is a rich feed, excellent for poultry but little used for other feeding. Cowpea straw is an excellent roughage and nearly as valuable as the hay.

(6) Cheaper cowpea seed will result in the much more extensive growing of the crop. Harvesting for seed can be done most cheaply by the use of machinery. The crop should be cut with a mower or self-rake reaper when half or more of the pods are ripe. When thoroughly dry the thrashing may be done with an ordinary grain separator with some modifications, with a two-cylinder cowpea thrasher, or with a one-cylinder special machine which has all the thrashing spikes sharpened in addition to having ingenious devices which make it the most satisfactory thrasher for handling cowpeas.

(7) Cowpeas add nitrogen to the soil and improve its mechanical condition. They are most profitably grown in rotation with other crops. The following rotations are good ones:

(*a*) Cotton, three years; corn and cowpeas fourth year; and then cotton again. This is all right on the better soils of the South, but the cotton should be planted only two years in succession on the poorer soils.

(*b*) Wheat or oats with cowpeas each season after the removal of the grain crop, the land being seeded to grain again in the fall, making two crops a year from the same land.

(*c*) Cotton, first year; corn and cowpeas, second year; winter oats or wheat followed by cowpeas as a catch crop, third year; and then cotton again.

(8) The most valuable varieties are the Whippoorwill, the Unknown or Wonderful, the New Era, and the Iron for field purposes; and the Blackeye for table use.

(9) The Iron cowpea is practically immune to the two serious diseases, wilt and root-knot, which attack the other varieties more or less. It alone should therefore be grown wherever these diseases are prevalent.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 319.

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DEMONSTRATION WORK IN COOPERATION WITH SOUTHERN FARMERS.

BY

S. A. KNAPP,

Special Agent in Charge of Farmers' Cooperative Demonstration Work, Bureau of Plant Industry.

WASHINGTON:
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1908.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 3, 1908.

Sir: I have the honor to transmit herewith a manuscript entitled "Demonstration Work in Cooperation with Southern Farmers," by Dr. S. A. Knapp, Special Agent in Charge of Farmers' Cooperative Demonstration Work, and recommend that it be published as a Farmers' Bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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DEMONSTRATION WORK IN COOPERATION WITH SOUTHERN FARMERS.

INTRODUCTION.

The Farmers' Cooperative Demonstration Work conducted by the United States Department of Agriculture through the Bureau of Plant Industry was inaugurated under authority of Congress in January, 1904, primarily because of the depredations of the Mexican cotton boll weevil in the State of Texas. By the rapid spread of this pest east and north it had then become evident that it would in time invade all of the cotton-producing States. This occasioned a general alarm among the cotton planters and in the industrial centers of the entire country. For a number of years prior to 1904 the Mexican boll weevil had been steadily encroaching upon the cotton-producing lands of Texas, until it had spread from the Rio Grande to a short distance beyond the eastern boundary of the State and threatened the entire cotton industry of the South. In sections where cotton was the sole cash crop the invasion of the weevil and the consequent loss of the cotton crop brought disaster to every interest and so completely demoralized financial conditions as to produce in some sections a panic.

The cotton crop had been generally produced upon a credit system by securing advances from merchants and bankers. Upon the advent of the boll weevil, confidence in securing a cotton crop was impaired and in some districts almost totally destroyed. The usual advances were either withheld or limited; labor became discontented and sought other sections or other States, and tenant farmers unable to obtain advances removed to noninfested districts, a marked decline in property values resulting.

These circumstances created a demand for immediate relief which appealed to the entire country, as the loss of the cotton crop would be a national calamity. In response to this appeal Congress made an emergency appropriation in January, 1904, which has been continued each year, thus affording opportunity for the growth and enlargement of the work.

THE TWO BRANCHES OF THE DEMONSTRATION WORK.

As at present organized and developed, the Farmers' Cooperative Demonstration Work may be said to consist of two divisions: (1) The demonstration of improved methods of agriculture in the weevil-infected districts, which is the natural outgrowth of the original plan, and (2) the extension of the same principles to other Southern States beyond the range of weevil infestation.

The territory covered by the first division of the work includes eastern and northern Texas, southern Arkansas, Oklahoma, Louisiana, and a portion of Mississippi. The total area thus covered is more than 300,000 square miles. The work in Arkansas, Oklahoma, and Mississippi has been broadly inaugurated only since October, 1907.

The second division of the work was commenced in Mississippi in March, 1906. In cooperation with the General Education Board of New York, this work in 1907 was conducted in a limited way in Alabama and Virginia, and has recently been extended into North Carolina, South Carolina, and Georgia. The expenses of this division of the work are defrayed by the General Education Board, which has appropriated the sum of $69,000 for demonstration work during the year commencing October 1, 1907. The board has shown deep interest, hearty cooperation, and a very broad philanthropy in this work of reaching the rural masses and bettering farm conditions.

PLAN OF ORGANIZATION.

The Farmers' Cooperative Demonstration Work is conducted by the writer as special agent in charge, who reports directly to the Chief of the Bureau of Plant Industry. A corps of field agents classified according to territory in charge, as State, district, and county agents, is employed. The county agents are appointed mainly on the advice of local committees of prominent business men and farmers conversant with the territory to be worked. Each agent has in charge the practical work in one or more counties, strictly under such general directions as may be issued from the central office at Washington, D. C. The field agents have been selected with special reference to a thorough knowledge of improved agriculture and practical experience in farming in the sections to which appointed. District agents are expected to have not only a knowledge of scientific agriculture, but to be practical farmers and to have had considerable experience in the demonstration work. State agents are strong and capable men, who have shown their ability to successfully carry out the instructions of the central office over a large territory, and they are especially qualified for the work by the possession of the tact necessary to influence men.

The term "demonstration farm" is used to designate a portion of land on a farm that is worked strictly according to our instructions. This is visited by an agent as often as once a month, if possible, to see that these instructions are carried out and to give any further advice necessary.

A "cooperator" is a farmer who agrees to work a part or all of his crop according to our instructions, but a Department agent only visits him in exceptional cases.

During the ensuing year there will be employed in the cooperative demonstration work 59 agents paid from Government appropriations, and in the extension work 84 agents paid by the General Education Board. With this force about 12,000 demonstration farms had been established up to February 1, 1908, and 20,000 farmers had agreed to cooperate and make reports as to results.

SCOPE OF THE DEMONSTRATIONS.

The Farmers' Cooperative Demonstration Work is a system by which the simple and well-established principles of successful farming are directly taught to the men on the farms. The men who toil on the farms to produce the food that nourishes all the people, and who in a large measure provide the resources that support our civilization, are as justly entitled to a knowledge of the best that science and general experience have evolved for increase of production and for the betterment of agricultural conditions as the youth of our country are entitled to an education that will fit them for a broader citizenship.

One of the most serious problems in the reform of agricultural methods has been how to influence the farmer to adopt improved practices. It has been found that the mere dissemination of printed information sometimes does not accomplish this result, and therefore the method of neighborhood farm demonstrations in cooperation with progressive farmers has been evolved. The effect of a field demonstration is immediate and positive, and reaches all classes.

By actual count, it is determined that the number of farmers who annually visit each demonstration farm ranges from thirty to a hundred. If the average is placed as low as thirty the total number visiting 12,000 demonstration farms in one year would be 360,000. If we add the cooperating farmers, the aggregate is greatly increased.

The teaching by object lessons is more effective where it is simple, direct, and limited to a few common field crops, such as cotton, corn, cowpeas, and oats in the South, so that the comparisons may be evident and accepted at a glance. If general success can be secured with these standard crops, further diversification follows as a natural result.

Briefly stated, the salient features of the cooperative farm demonstrations are as follows:

(1) Better drainage of the soil.

(2) A deeper and more thoroughly pulverized seed bed; deep fall breaking (plowing) with implements that will not bring the subsoil to the surface.

(3) The use of seed of the best variety, intelligently selected and carefully stored.

(4) In cultivated crops, giving the rows and the plants in the rows a space suited to the plant, the soil, and the climate.

(5) Intensive tillage during the growing period of the crops.

(6) The importance of a high content of humus in the soil. The use of legumes, barnyard manure, farm refuse, and commercial fertilizers.

(7) The value of crop rotation and a winter cover crop on southern farms.

(8) The accomplishing of more work in a day on the farm by using more horse power and better implements.

(9) The importance of increasing the farm stock to the extent of utilizing all the waste products and idle lands of the farm.

(10) The production of all food required for the men and animals on the farm.

(11) The keeping of an account with each farm product, in order to know from which the gain or loss arises.

THE INSTRUCTIONS.

Our instructions have the following advantages: (1) What the Department of Agriculture at Washington knows from its vast store of information about the special crop under consideration; (2) what the State agricultural experiment stations in the South have demonstrated to be the most advantageous methods; (3) what the best farmers in the South have tested and proved to be the most successful practices upon the farm, and (4) the knowledge obtained by the traveling agents of this demonstration work, who visit and have personal knowledge of the localities in the State in which they are stationed. Even then the instructions given are along the lines of correct principles, leaving many details to the good judgment of the farmer.

In this cooperative work great stress is laid upon a more thorough preparation of the soil in the autumn, because in our southern climate the frosts do not penetrate the soils sufficiently to open them and admit air; we must therefore do by plowing in the fall and by some winter cultivation what Nature does in the colder North.

In the richest soils there is but little food ready prepared for the plant, and Nature's plan is that this food shall be prepared more or less daily by the action of the air, the moisture in the soils, and the sun. These three agents make active the forces that prepare the food, so the plant can be properly nourished. This can not be done without plowing and cultivating to admit the air, and the earlier this work is commenced before the winter the greater the effect it will have upon the crop of the following season.

The effect of using good seed is not sufficiently appreciated, nor perhaps is it understood just what makes good seed. It must be the best variety for the purpose, carefully seleoted early in the fall and stored in a dry place. The reasons for very frequent cultivation are the admission of air, the conservation of moisture in the soil, and the prevention of a surface crust.

Young plants require excellent cultivation, just as young animals require the best food and care.

The judicious use of commercial fertilizers is one of the most important matters in modern agriculture, for this furnishes plant food directly and indirectly to the young plants. For soil improvement we must largely depend upon barnyard manure, the compost heap, and leguminous plants, such as cowpeas.

The importance of doing more as well as better work in a day has not been sufficiently impressed upon the southern farmer. This requires the use of stronger teams and better tools. Working 3 acres in a day where 1 is worked now and working each acre three times as well is a problem in profit easily understood after demonstration.

HOW FARMERS ARE INFLUENCED TO ADOPT BETTER METHODS.

In the South nearly all the merchants, bankers, and lawyers in the towns and smaller cities own farms and are intensely interested in agriculture. They form an effective center of influence, easily convinced of the value of the cooperative demonstration plan by reason of their high intelligence. Meetings are called and the work inaugurated. No further argument is necessary after the demonstrations have been made. Facts do the talking. The teachers in the public schools are generally alert and render most valuable assistance. The agricultural colleges and agricultural experiment stations give hearty cooperation. Thus, general interest is aroused in these demonstrations, which leads to careful observation and study on the part of the farmers and of the community. Public meetings are held for the discussion of these plans. In the cotton-producing States the first instructions include cotton as the main cash crop, corn as the standard food for work animals and the basis for more stock on the farm, cowpeas for food and for the renovation of the soil, oats or wheat as a winter cover crop, and the meadow and the pasture as the most economical source of food for farm stock. When the farmer has mastered these crops he is ready for diversification in any desired direction.

In districts where cotton is not the standard cash crop, instruction is given in whatever replaces cotton as a money-earning crop. These simple lessons at the start are gradually made progressive until they cover all information necessary to success in the agriculture of the district.

As a means of reaching thousands of farmers with whom our agents do not come in personal contact, systematic use is made of the newspapers. Every bulletin or letter of instruction sent to cooperators is also furnished to about 2,000 county newspapers, and by most of them published in full. The hearty cooperation of the press has been of great value to the demonstration work.

THE CULTURAL SYSTEM FOR PRODUCING COTTON UNDER BOLL-WEEVIL CONDITIONS.

As it is evident that the cotton boll weevil will soon spread over the entire cotton-producing territory of the United States, it is a matter of general interest to know how cotton is at present produced with the weevil present.

Success in making a cotton crop under boll-weevil conditions is based upon three principles. It was found (1) that the numbers of the weevils could be limited so that they would not become totally destructive to the crop until the first and middle crops are out of danger; (2) that the cotton plant can be so bred and selected as to throw nearly its whole life forces into the lower and middle crops, and (3) that the plant can be so hastened to maturity by the application of cultural methods that most of the bolls will be developed to the safety point before the weevils are too numerous.

Guided by the principles just mentioned, the Bureau of Plant Industry has worked out a cooperative plan of producing cotton under boll-weevil conditions, which is known through the South as the "cotton-cultural system." This plan is based upon our knowledge of the cotton plant and upon the life habits of the boll weevil as ascertained by the Bureau of Entomology.[a] Its chief features may be briefly mentioned, as follows:

(1) The destruction of the weevils in the fall (*a*) by burning the cotton stalks early in the fall while the weevils are still upon them and (*b*) by burning all rubbish in and about the field which might serve for hibernating quarters.

It is so difficult to secure a general adoption by the farmers of the plan of early burning of the cotton stalks that we have allowed the stalks to be turned under provided the immature bolls are destroyed

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[a] See Bulletin No. 51 of the Bureau of Entomology.

(2) Immediately after destroying the bolls breaking (plowing) the field as deep as conditions will allow.

(3) The shallow winter cultivation of the soil.

(4) As early planting as the season will allow with safety to the crop.

(5) The planting of early-maturing varieties of cotton.

(6) The use of fertilizers.

(7) Leaving more space between the rows, and on ordinary uplands having a greater distance between plants in the row than is usually allowed. On rich or highly fertilized lands it is better to crowd the plants slightly in the rows to avoid the excessive growth of the stalks.

(8) The use of the toothed harrow before and after planting and on the young cotton.

(9) Intensive shallow cultivation.

(10) Agitation of the stalks by means of brush attached to the cultivator.

(11) Picking up and burning the squares that fall, where practicable.

(12) Controlling the growth of the plant if excessive by barring off or topping.

(13) Selecting the seed.

(14) The rotation of crops and the use of legumes.

It will be noted that the system as outlined has a twofold object: (1) To reduce the number of weevils and (2) to aid early maturity in order to obtain a crop in advance of the weevil.

A few remarks concerning the main features of this plan may prove of value.

DESTRUCTION OF THE WEEVILS.

One of the greatest dangers to the cotton crop is the wintering of large numbers of weevils. By a failure to destroy early in the fall the immature cotton bolls and the rubbish in the fields, enough weevils may be wintered over to jeopardize the crops the ensuing year. If the immature bolls and the field rubbish are destroyed the stalks may be safely plowed under. The rubbish in the field which may serve for hibernating quarters includes the borders and fence corners.

Two methods of destroying the over-wintered weevils while they are feeding on the tender terminal buds are advocated: (1) They may be hand picked and burned or (2) some may be destroyed by the use of the harrow and brush.

FALL AND WINTER CULTIVATION OF THE SOIL.

After the destruction of the bolls in the fall, breaking (plowing) the field 1 or 2 inches deeper than usual assists in the destruction of the weevils and in the preparation of the field for successful cropping the following season. In order to air the soil and destroy grass, shallow winter cultivation of the soil should be practiced, i. e., working the land with a toothed harrow or a disk once every twenty or thirty days during the winter, as the weather may permit. The soil should be in excellent condition at the time of planting.

EARLY PLANTING AND THE USE OF EARLY-MATURING VARIETIES.

The object of early planting is to hasten the maturity of the crop. The Bureau of Entomology has shown that the weevils do not multiply until the squares begin to form and do not generally become numerous enough to destroy the entire crop before the last of July. In addition to this, early planting has been found generally helpful against cotton pests, such as the bollworm and the leafworm. Furthermore, the winter rains usually leave the soil with plenty of moisture, while in the spring there is liable to be a drought which may retard germination in late planting.

Varieties of cotton differ in time of maturity, and the same variety may differ owing to soil, moisture, fertilization, cultivation, etc. The planting of early-maturing varieties of cotton is not only important as an aid in securing a crop, but also as a means of destroying the weevil. The early-maturing cotton can be gathered and the immature bolls destroyed before it is time for the weevils to go into winter quarters. If all growers would plant early-maturing cotton and follow the plan here outlined it would result in greatly lessening the damage of the weevil.

In advising the planting of early-maturing cotton it is not the intention to advocate the exclusive use of small-boll cotton. These varieties may be better adapted to the northern limits of the cotton belt, but in nine-tenths of the cotton-producing territory there are large-boll varieties which can be just as successfully grown under boll-weevil conditions as the small-boll cottons. They must be varieties that are generally vigorous and that put out short-jointed fruit limbs close to the ground.

USE OF FERTILIZERS.

The use of fertilizers, especially acid phosphate and potash, to hasten maturity and increase fruitage, as well as the use of cotton seed meal when necessary to promote vigor and growth, is recom mended. Soils and methods of application are fully explained, and it has been demonstrated that a small quantity of fertilizer properly applied accomplishes marvelous results.

SPACING BETWEEN PLANTS AND ROWS.

Planting in rows wider than usual and allowing more space in the row on light lands are advised under boll-weevil conditions. Special attention must be directed to have the rows the proper distance apart and to thin the plants in the rows. There must be width enough for the sun's rays to reach the earth between the rows and thus aid in destroying the larvæ of the weevil.

Generally speaking, more space to the plant makes a better stalk with more limbs, more bloom, and a higher grade of cotton. The spacing between the rows and in the rows must depend on the soil and the variety of cotton. More space should be given to fertilized than to unfertilized cotton. If, however, extreme space is allowed between plants in the rows and intensive cultivation is given there may be enough stimulus imparted to the growth of the plant to actually retard maturity unless the growth is controlled by barring off, as explained later; hence, on rich lands it is best to give plenty of space between the rows and to crowd the plants a little in the rows.

USE OF THE TOOTHED HARROW.

The use of the toothed harrow as soon as the crop comes up is of sufficient importance to warrant special mention. After early planting the germination is frequently slow and the earth may become crusted. The harrow may be used to break the crust before the plants are up and should be used soon afterwards to keep the soil loose so that the plants will take on rapid growth at once. The crop is surprisingly advanced by the judicious use of the harrow.

INTENSIVE CULTIVATION.

Plowing or cultivating deep the first time and shallow at all subsequent times is an important feature of good cotton production. It destroys weeds, increases the plant food, and conserves moisture, consequently hastening maturity. Under boll-weevil conditions the cotton crop should be cultivated every week. Some of our most successful cooperators have cultivated fifteen times and continued till picking commenced.

AGITATION OF STALKS.

Violent agitation of the cotton stalks when cultivating or plowing, by means of a brush attached to the cultivator or plow, is recommended. Some farmers attach a chain to the tongue and smooth poles to the whiffletrees, and also a pole to the handles, so as to brush the stalks more than once in passing. Bundles of soft, leafy twigs are better. This knocks off the infested squares. The great majority of squares fall off naturally in a very few days after they become infested. Abundant testimony has come from our cooperators to show that as long as weekly cultivation of the crop with violent agitation of the stalks is continued the damage done by the boll weevil is greatly reduced.

PICKING UP FALLEN SQUARES.

An important aid toward the destruction of the weevils is picking up the squares that fall. If two or three generations can thus be destroyed, it will result in retarding the increase of the weevil and in adding to the cotton crop. This reduces the rapidity with which the weevils multiply and is a great aid in saving the crop.

BARRING OFF OR TOPPING.

Under boll-weevil conditions the main cotton crop must be made upon the lower and middle limbs. There is no use of a tall plant. The growth of the plant should therefore be controlled by barring off or topping. As soon as the plant indicates too rapid growth, bar off on each side, thus slightly root pruning and retarding upward growth. The tendency will then be to throw more vigor into the lower limbs and to put on more fruit. This method is especially valuable on rich bottom lands where the stalks frequently grow 6 to 7 feet high. It should be noted that with the boll weevil no top crop is made; hence, more bottom crop must be secured, requiring a low, limby, vigorous plant.

SELECTING AND STORING SEED.

Scarcely any item in the cultural system is of more importance than the selection of the seed as an aid to early maturity in the following crop. The largest, best, and earliest bolls from the most vigorous short-jointed plants should be selected for seed in advance of the general picking and be stored in a dry place. The planting of early-maturing varieties and the selection of seed from the earliest and best bolls on the most vigorous and best developed stalks are fundamental principles in growing cotton irrespective of the boll weevil and can not be too closely followed.

ROTATION OF CROPS AND USE OF LEGUMES.

The Bureau of Plant Industry in all its instructions seeks to build up soil energy and to improve the mechanical condition of the soil as well. An important factor to this end is rotation of crops and the increase of humus by plowing under green plants, especially cowpeas. This builds up the soil and renders it more porous and responsive.

Some of the serious difficulties in cotton production arise from the growing of consecutive crops of cotton on the same land. This reduces fertility and hence operates against early maturity. With the best of efforts to clear fields of the weevil in the fall by burning the stalks and deep plowing, some weevils will survive, and a few soon infest a field. By planting one half of the land to corn and cowpeas and the other half to cotton, as much cotton can be produced as formerly and the land will be gradually restored to its original fertility. The corn and cowpeas will also add materially to the income of the farm, but the special reason urged for such rotation under boll-weevil infestation is that the crop of corn and peas leaves the field free from the weevil, as it feeds only upon cotton. It is evident that with the boll weevil it requires more labor to cultivate an acre of cotton; consequently, only as many acres should be planted as can be given the best attention, so as to produce a maximum crop, thus leaving more land for cereals and for meadows and pastures.

DEMONSTRATION WORK ON VARIOUS FARM CROPS.

The Farmers' Cooperative Demonstration Work, as before stated, aims to cover the entire scope of the management of the standard crops in the sections where the work is conducted. In addition to the cotton-culture system, which is the main feature of the work in many localities, it may be well to give brief mention of some of the cooperative work on other crops now under way, such as corn culture, the use of soil-renovating crops, and the production of good farm seeds.

CORN CULTURE.

Corn is the main grain dependence for farm stock and can be successfully raised in most portions of the South. Any considerable increase in its annual production would have a marked effect upon the value of the unused lands for grazing purposes and would perceptibly increase the income of the farms. The importance of corn for food and for rotation with other crops gives it a rank next to cotton as a standard farm crop. Notwithstanding this, its cultivation has been singularly neglected until the average yield per acre has fallen below the profit line in many States. Even at the high value per bushel allowed, the corn crop in many of the Southern States does not pay a living wage or a fair rent value for the land.

There is abundant proof that large and profitable crops of corn can be produced in the South by the use of the best seed and improved methods. The planting of low-grade seed in a shallow and impoverished seed bed is responsible in the main for deficient yields and quality. However, to secure the best results other reforms must be made, such as better drainage, an adjustment of distances between the rows and the stalks in the rows to meet the requirements of soil and climate, intensive cultivation of the crop, the use of cowpeas in the corn, and the following of the corn with a winter cover crop.

The Farmers' Cooperative Demonstration Work includes instruction along all of these lines, and the results have been most encouraging. Our investigations show that not even 1 per cent of the lands in the South planted to corn are plowed deeply enough at breaking, that they have not sufficient humus, and that they are not given the proper tillage to make the best crop. Seed is so generally defective that only about one-third of so-called good seed is suitable for planting if maximum yields are expected. Along these practical lines we are conducting cooperative demonstrations with the object of increasing the corn crop in the South Atlantic and Gulf States at least threefold per acre without additional cost. A system of seed selection for improving the quality and increasing the yield and methods of storage for the preservation of vitality are outlined, detailed instructions being given on application.

Selection of Seed Corn.

The object of the average farmer in planting corn is to secure the largest crop of good corn possible under the conditions. The selection of the seed is very important.

For the best results corn should be selected in the field. The Japanese select their rice seed before the harvest.

The model ear of corn is only a small part of the problem. The stalk, the leaf, the root habits, the husk, and the environment of the plant from which the ear is taken must be considered. Most of the Southern States are subject to a shorter or longer drought during the period of growth of the corn crop, and the crop will depend largely upon the drought-resisting habits of leaf and roots. Some varieties of corn which are model in ear have so open a husk that the weevils destroy much of it while in the field. Again the ear in the crib does not tell how many weak or bastard stalks grew in the vicinity.

COWPEAS AND OTHER SOIL-RENOVATING CROPS.

As just stated, corn requires a strong, well-tilled soil, and upon thin land, deteriorated by bad management, the yield soon drops below a remunerative average. Such lands will, however, profitably produce other crops of great value for the sustenance of farm stock, and, in addition, the growing of these crops will provide an excellent means of soil renovation. Lands that are now producing 10 bushels of corn per acre will with much less labor produce 1¼ tons of cowpea hay per acre, equal in nutritive value to 31 bushels of corn, or they will yield 1¼ tons of peanut hay per acre, equal in nutritive value to

23¾ bushels of corn, and in addition a peanut crop of 25 bushels per acre may be secured.

On rich lands that under good culture will produce 40 or more bushels of corn per acre satisfactory results can be secured by planting cowpeas between the rows of corn. Even rich bottom lands rated to yield 40 bushels of corn per acre if sown to alfalfa frequently produce 5 tons of hay per acre in a season, equal in feeding value to 105½ bushels of corn. In addition, such crops as cowpeas, peanuts, and alfalfa rapidly enrich the soil and leave it in excellent mechanical condition for the ensuing year.

Generally speaking, poor hill lands should not be used for corn culture unless they are placed under a thorough system of renovation, or unless fertilization with stable manure or compost is practiced to a high degree.

SEED FARMS.

The good-seed problem has been a most difficult one to solve in the South. Very few farmers have paid any attention to planting pure seed or keeping it pure when planted, and still fewer have tried to improve their seed by selection. Not one farm in one hundred in the South has proper storage for good seed. Through field agents prominent farmers in every county have been induced to establish seed farms, where the cultivation of the crop and the selection and storing of the seed are supervised by agents of this cooperative demonstration work under an agreement that the seed produced shall be distributed to the farmers at a moderate price. The best seeds for a given section are observed and a general interest is aroused among the farmers to plant a separate seed patch on every farm and carefully select for improvement.

PRACTICAL RESULTS ACCOMPLISHED.

The field operations in connection with the Farmers' Cooperative Demonstration Work extend over such a vast territory that it is difficult to state results in a concrete way. The following statements give the more important items in condensed form:

Amount available from Congressional appropriations for year 1907–8	$77, 739. 80
General Education Board, contribution [a]	69, 000. 00
Slater fund [a]	1, 000. 00
Voluntary local contributions (estimated) [b]	20, 000. 00
	167, 739. 80

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[a] The responsibility for handling these funds remains in the hands of the contributors, acting under the advice of the agent in charge.

[b] Many counties ask for more demonstration farms and more improved seed than the Department of Agriculture can furnish on account of lack of funds. Some of these pledge the money necessary to thus supplement the work.

Agent in charge	[illegible]
General assistant agents	[illegible]
Field agents	[illegible]
States partially or wholly worked	[illegible]
Public meetings held annually*	[illegible]
Circulars distributed annually	200,000
Number of demonstration farms, 1907–8, of which exact records are kept in central office	12,000
Number of cooperating farmers, 1907–8	[illegible]
Number of farmers visiting the demonstration farms annually (conservatively estimated)	[illegible]

Great interest is everywhere manifested in better preparation the soil, in planting selected seed, and in general betterment.

Thousands of prize contests have been started in cotton and production among farmers and also among boys on the farm.

Thousands of letters bearing testimony to the value of the have been received, but it is impossible to present any extended of these within the limits of a Farmers' Bulletin.

The following extracts from letters received show the estimate of the value of this demonstration work:

MARSHALL, TEX., *October 10, 19*

We, the undersigned committee for Harrison County, Tex., make the preliminary report on the Farmers' Cooperative Demonstration Work done past season in this county.

On account of the ravages of the boll weevil, Harrison County, Tex. threatened with a disaster in the loss of the cotton crop that would affect material interest in the county. The loss of money was not the sole tion. Our tenants and farm laborers would to a large extent leave the and it would thus permanently injure our Commonwealth. In this we appealed to the United States Department of Agriculture through advice and aid. You came to our county and organized the work in 1907, under an arrangement by which the Department of Agriculture furnish superintendence and the people of this county would raise enough to buy improved seed for the demonstration farms. The citizens of the promptly raised and deposited in bank $1,000 and later contributed making a total of $1,700 invested in better seed. All agreements Department of Agriculture and the people were promptly and carried out. Almost without exception this was the worst season this has ever known for producing cotton, but without reservation we wish to the following statements:

(1) The results of the demonstration work have been in the highest satisfactory to our people, and they regard this movement as one of the ever made for the upbuilding of our section.

(2) Our people are unanimous in asking for its continuance and would the discontinuance of the work as an untold disaster.

(3) Among the many good things accomplished we enumerate the

(*a*) It established over 300 demonstration farms, scattered over the county.

(*b*) It taught better culture and introduced better seed. These two alone were worth more than $100,000 this year to our county in actual cash.

say nothing of future benefits. The improvement was so apparent that the observing traveler on the highways could pick out every demonstration field.

(*c*) This demonstration work saved a stampede of tenant farmers and laborers from the farms.

(*d*) It gave confidence to the merchants and bankers that a crop would be made, and thus promoted credit.

(*e*) It demonstrated to the farmers that a crop of cotton could be made under extremely adverse condition of weather and insect pests, and they enter upon another year with perfect confidence.

Great credit for the success of this year's work is due to the excellent supervision of W. F. Proctor, State agent for Texas, and to the untiring energy of T. O. Plunkett, local agent.

JNO. H. POPE.	M. SCULLY.
W. T. TWYMON.	H. B. MCWILLIAMS.
P. G. WHALEY.	W. L. MARTIN.

The above committeemen are well known to me and are among the most substantial and reliable citizens of Harrison County, Tex., and I also personally indorse the statements made.

H. S. LYTTLETON,
County Judge, Harrison County, Tex.

PALESTINE, TEX., *January 1, 1908.*

DEAR SIR: We, the undersigned citizens of Anderson County, Tex., desire to acquaint you with the character of the work done in this county since last March through the department known as the Farmers' Cooperative Demonstration Work, and to call your attention to some of the beneficial results accomplished.

The work of the Department in this county was done on a comparatively small scale. The enterprising board of trade of the city of Palestine contributed $600 to this work, which constituted the sum of local support the work has had in the way of money contributed. But, notwithstanding this, the result of the work accomplished has been most gratifying in many ways.

Two hundred demonstration farms have been established; improved seed has been used; improved methods of cultivation have been employed, and a fine showing has been made. Outside of these demonstration farms a conservative estimate places the average yield of cotton per acre at about 300 pounds of seed cotton, or about 1 bale to 6 acres. The record made by the demonstration farms is 608 pounds of seed cotton per acre as an average. The yield of corn per acre outside of the demonstration farms is certainly not greater than 15 bushels per acre. The demonstration farms show an average yield of 28½ bushels per acre.[a]

This good showing on the cotton is still further augmented by the fact that while it formerly took about 1,700 pounds of seed cotton to make a bale, the improved seed used on the demonstration farms produces a bale with 1,400 pounds of seed cotton.

These manifest results of the work are proving very stimulating to the farming interests, and the advantages of the work of this first season are simply incalculable. We believe that one of the certain results is a general awakening of the farmers of this county to the need of better seeds and up-to-date methods of farming.

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[a] The yields of cotton and corn given are unusually low because of the excessive rainfall.

It must be remembered that the showing that has been made this last year has been made under the most adverse circumstances imaginable. Adverse crop conditions have existed from the very beginning of the work.

We earnestly petition that the good work be continued in this county on as large a scale as possible, and we pledge the same our hearty cooperation and encouragement. * * *

John R. Hearne,
President, Board of Trade, and
President, Royall National Bank.
R. R. Claridge,
President, Texas Div., Southern Corn Association.
Y. L. Jones,
Merchant.
H. Horwitz,
Merchant.

H. W. Watts,
Ex-Sheriff, Anderson County.
Don M. Barrett,
Ex-Tax Collector, Anderson County.
S. M. Paul,
Farmer.
J. J. Strickland,
Representative,
Thirtieth Legislature.

Denison Board of Trade,
Denison, Tex., January 2, 1908.

Dear Sir: Referring to your esteemed favor of recent date, beg to say that we greatly appreciate your interest and cooperation in our efforts for agricultural advancement, and we expect great good to result from the work planned next year. The work of the past year has served to thoroughly arouse our people to an understanding of the great work that your Department is doing in the interest of agricultural advancement.

Your work in this community during the past year has been of inestimable value to our people. There has been a wonderful awakening of interest among our farmers, who are now on the alert for new ideas and progressive methods. There was a time, perhaps, when farmers regarded the work of the Department of Agriculture as empty theory and spurned the advice of what they pleased to term "book farmers," but they now realize the science of agriculture and its wonderful possibilities for improvement and for increasing their earning capacity. Such an awakening is manifest on every hand in the vicinity of Denison, where wonderful progress has been made during the past year. I feel safe in the assertion that there has been more scientific and methodical work on the farms about Denison during 1907 than ever before. * * * This is evidence of real prosperity—prosperity so firmly established that our little city and the surrounding country hardly realized the existence of the financial flurry which so upset conditions throughout the country.

We regard the work in the interest of agricultural advancement as being the most productive effort of this organization, and we feel deeply indebted to you for cooperation, which has made our work much more effective than it could have been otherwise. We feel that the object lessons provided by you last year were very effective, and the establishment of the 30 demonstration and cooperative farms planned for the next year insures even greater progress. Two of the farmers who operated demonstration plats the past year under the able direction of Mr. J. L. Quicksall have sold all their Triumph seed they had to spare at $1 per bushel.

We are especially anxious to encourage the corn growers whom we have succeeded in so thoroughly arousing during the past year. I have never known a much interest in the improvement of corn as is in evidence here at this time. * * * We are anxious to render any possible service that will facilitate your work in the vicinity of Denison, believing that your continued cooperation will assist us in making this the greatest agricultural section of the Southwest.

Very truly yours,
T. W. LARKIN,
Secretary.

TAYLOR, LA., *January 5, 1908.*

DEAR SIR: Some four years ago I worked a plat of land by your cultural method, which gave me much better results than the usual methods previously used. I have been following the same instructions in part for the last three seasons, and find this method gives better results, especially the thorough preparation of the seed bed and the distance between rows and plants. I find the crop much easier worked and the yield better in quality, as well as quantity. I also have tried to help a good thing along by showing your instructions and my crop to others and by having my tenants work by same. One of the parties to whom I read the instructions and showed the crop asked me to see his crop last summer, saying he had worked it my way and had the best crop he ever raised in his life. I think he had a fine crop for the season.

Respectfully,
W. C. WALL.

CLARENDON, ARK., *December 20, 1907.*

DEAR SIR: I took up your plan of farming in 1906 in a small way with good results; in fact, was so well pleased with it that I planted and cultivated something like 400 acres this year. I followed your directions in preparation and cultivation, using 200 pounds of phosphate per acre. While we had the wettest and coldest and most backward spring I ever knew, causing me to plant the greater part of my crop over the fourth time and as late as June 9 to 12, then only getting about half a stand on most of it, and after that date only had rain enough to keep the plows out of the field a few hours until picking time, I am satisfied with the result, some of it paying me as high as $30 per acre net rent, the lowest $6 per acre, averaging about $13 per acre net. I more than doubled my yield of corn. I expect to go at it more extensively next year. I have had my plows going for two weeks, preparing cotton land for 1908.

Very respectfully,
W. S. JEFFRIES.

STONEWALL, LA., *December 13, 1907.*

DEAR SIR: Having spent twenty-five years in paying for cotton lands and a cotton gin and otherwise getting in shape to grow and handle cotton to advantage, we have studied and watched with deep interest every movement which was calculated to relieve us from the ravages of the boll weevil, and now we write to thank you and Mr. Cowden (agent) for the work done in this community in the way of establishing demonstration farms this year. We feel sure this is the best manner to reach most of our people, who have grown skeptical of book farming, but are easily convinced by a practical application of your methods. We have tried your plans for two years and think it our only hope to outwit the boll weevil.

Trusting you may be able to continue your work in our parish next year,

We are, with regards, yours truly,
J. M. & M. G. NELSON.

THE BUSINESS MEN'S LEAGUE OF HELENA, ARK.
Helena, Ark., January 11, 19

DEAR SIR: Our league has on foot a movement to increase the productio acre of cotton and corn in this section.

Two years ago an experiment was conducted under the immediate ca Messrs. E. D. Pillow and H. G. Stephens, one of your representatives ha a general supervision of the experiment. No fertilizer was used, but the tural methods adopted proved wonderfully beneficial and a large yield of resulted. During the season just past, Mr. Stephens conducted an experi upon his own behalf, using nitrate of soda as a fertilizer for cotton and seed meal for corn. He has made us a report which we will publish, and together with a letter from Mr. E. D. Pillow, will be mailed by us to 1,000 farmers in this section. * * * We would also ask your cooperat in this matter and would like to know if it would be possible to secure services of a representative of the Agricultural Department to make a of inspection at short intervals for the purpose of aiding these farmers by of instruction and general information. The experiment would be mor to prove profitable if some one would make the rounds and let it be know advance that an inspection would be made.

Kindly write us fully upon this subject and tell us to what extent and what manner you can aid us in this movement.

Yours truly, E. C. Ho

CONCLUSION.

It has been proved by our cooperative demonstration work that following the instructions of the Bureau of Plant Industry a g crop of cotton can be raised in the worst-infested boll-weevil distr and despite the ravages of this pest. It is possible that the fu may discover some better method of meeting the boll-weevil proble but experience has shown that the method outlined is the only one at present. The boll weevil has now covered a large portion Texas, Louisiana, Arkansas, Oklahoma, and several counties in Mi issippi. It is annually invading new territory with a column miles long and in numbers sufficient to cover every stalk of cotto a width of 30 miles. A cotton crop can be produced despite the weevil, and the sooner American farmers face the situation the bet it will be for all concerned. To demonstrate the truth of this the is one object of the Farmers' Cooperative Demonstration Wor

In the foregoing pages have been mentioned only some of the li of demonstration which have been undertaken for rural uplifti The results have far exceeded our expectations, and the farmers ha accepted the work gratefully and have cooperated to the best of th ability in every undertaking. It is along such lines as these that gr economies can be practiced and valuable reforms wrought for the be terment of rural conditions and for solving the problems of the far

FARMERS' BULLETINS.

The following is a list, by number, of the Farmers' Bulletins available for distri-
ution. The bulletins entitled "Experiment Station Work" give in brief the results
f experiments performed by the State experiment stations. Titles of other bulletins
re self-explanatory. Bulletins in this list will be sent free to any address in the
nited States on application to a Senator, Representative, or Delegate in Congress,
r to the Secretary of Agriculture, Washington, D. C. Numbers omitted have been
iscontinued, being superseded by later bulletins.

2. The Feeding of Farm Animals. Pp. 40.
4. Hog Cholera and Swine Plague. Pp. 16.
5. Peanuts: Culture and Uses. Pp. 24.
7. Flax for Seed and Fiber. Pp. 16.
8. Weeds: And How to Kill Them. Pp. 30.
9. Souring and Other Changes in Milk. Pp. 22.
0. Grape Diseases on the Pacific Coast. Pp. 15.
2. Silos and Silage. Pp. 30.
3. Peach Growing for Market. Pp. 24.
4. Meats: Composition and Cooking. Pp. 31.
5. Potato Culture. Pp. 24.
6. Cotton Seed and Its Products. Pp. 16.
2. Facts about Milk. Pp. 32.
4. Commercial Fertilizers. Pp. 38.
7. Insects Affecting the Cotton Plant. Pp. 32.
8. The Manuring of Cotton. Pp. 16.
1. Standard Varieties of Chickens. Pp. 48.
2. The Sugar Beet. Pp. 48.
4. Some Common Birds. Pp. 48.
5. The Dairy Herd. Pp. 30.
6. Experiment Station Work—I. Pp. 30.
8. The Soy Bean as a Forage Crop. Pp. 24.
9. Bee Keeping. Pp. 48.
0. Methods of Curing Tobacco. Pp. 24.
1. Asparagus Culture. Pp. 40.
2. Marketing Farm Produce. Pp. 31.
3. Care of Milk on the Farm. Pp. 40.
4. Ducks and Geese. Pp. 55.
5. Experiment Station Work—II. Pp. 32.
6. Meadows and Pastures. Pp. 30.
9. Experiment Station Work—III. Pp. 32.
1. Essentials in Beef Production. Pp. 24.
2. Cattle Ranges of the Southwest. Pp. 32.
3. Experiment Station Work—IV. Pp. 32.
4. Milk as Food. Pp. 39.
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8. Experiment Station Work—V. Pp. 32.
9. Experiment Station Work—VI. Pp. 27.
0. The Peach Twig-Borer. Pp. 16.
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3. Tobacco Soils. Pp. 23.
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5. Fish as Food. Pp. 32.
6. Thirty Poisonous Plants. Pp. 32.
7. Experiment Station Work—VIII. Pp. 32.
8. Alkali Lands. Pp. 23.
Potato Diseases and Treatment. Pp. 15.
2. Experiment Station Work—IX. Pp. 30.
3. Sugar as Food. Pp. 31.
5. Good Roads for Farmers. Pp. 46.
7. Experiment Station Work—X. Pp. 32.
8. Suggestions to Southern Farmers. Pp. 48.
9. Insect Enemies of Shade Trees. Pp. 30.
0. Hog Raising in the South. Pp. 40.
Millets. Pp. 30.
2. Southern Forage Plants. Pp. 48.
3. Experiment Station Work—XI. Pp. 30.
4. Notes on Frost. Pp. 24.
5. Experiment Station Work—XII. Pp. 32.
6. Breeds of Dairy Cattle. Pp. 48.
7. Experiment Station Work—XIII. Pp. 32.
8. Saltbushes. Pp. 20.
0. Rice Culture in the United States. Pp. 28.
Farmers' Interest in Good Seed. Pp. 24.
2. Bread and Bread Making. Pp. 40.
3. The Apple and How to Grow It. Pp. 32.
4. Experiment Station Work—XIV. Pp. 28.
6. Irrigation in Fruit Growing. Pp. 48.
8. Grape Growing in the South. Pp. 32.
9. Experiment Station Work—XV. Pp. 30.
0. Insects Affecting Tobacco. Pp. 32.
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122. Experiment Station Work—XVI. Pp. 32.
124. Experiment Station Work—XVII. Pp. 32.
125. Protection of Food Products from Injurious Temperatures. Pp. 24.
126. Practical Suggestions for Farm Buildings. Pp. 48.
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128. Eggs and Their Uses as Food. Pp. 40.
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133. Experiment Station Work—XVIII. Pp. 32.
134. Tree Planting in Rural School Grounds. Pp. 32.
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137. The Angora Goat. Pp. 48.
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144. Experiment Station Work—XIX. Pp. 32.
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147. Winter Forage Crops for the South. Pp. 40.
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1081 Issued April 8, 1908.

U. S. DEPARTMENT OF AGRICULTURE.

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FARMERS' BULLETIN 320.

Experiment Station Work,

XLVI.

Compiled from the Publications of the Agricultural Experiment Stations.

FISH FERTILIZER.
RECLAMATION OF SALT MARSHES.
BERMUDA HAY.
PROTEIN CONTENT OF FORAGE CROPS.
QUALITY IN WHEAT.
POTATO SPRAYING.
ANESTHETICS IN FORCING PLANTS.
FATTENING CATTLE FOR MARKET.
COTTON-SEED MEAL AND CORN SILAGE FOR COWS.
CARBONATED MILK.
PRESERVATION OF FENCE POSTS.

MARCH, 1908.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

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[a] Director.

[b] Special agent in charge.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

FISH FERTILIZER.[b]

Dried and ground fish or fish guano is a valuable fertilizer furnishing nitrogen and phosphoric acid, which finds quite extensive use in this and other countries where the material is available. The use of fish as a fertilizer in this country dates from the time of the earliest settlement at Plymouth, for it is reported that Squanto, an Indian, taught the Plymouth colonists to put a menhaden under each hill of corn at the time of planting to increase the yield. Untreated fish and fish waste have been used to a considerable extent as a fertilizer either directly or in composts with other materials ever since that time in regions where such materials are abundant and easily obtained.

The fish fertilizer or fish guano now commonly in use, however, is a manufactured product derived from two main sources—(1) the refuse from fish packing and canning establishments, and (2) the pomace from the extraction of oil from inedible fish. By far the larger proportion of the fish fertilizer produced in the United States is prepared from the menhaden, which is taken in immense numbers, especially along the Atlantic coast. According to a report of the U. S. Bureau of Fisheries, over 85,000 tons of fish fertilizer, valued at more than $1,500,000, was made from menhaden in the United States in 1903, and about 20,000 tons, valued at $200,000, from miscellaneous fish products. Catches of from 800,000,000 to 1,000,000,000 menhaden, weighing in the aggregate from 250,000 to 400,000 tons, during a single season on the North Atlantic coast, have been reported.

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Connecticut State Sta. Rpts. 1897, p. 257; 1900, p. 95; 1907–8, pt. 1, p. 44; Maine Sta. Bul. 88; New Jersey Stas. Rpt. 1901, p. 137; North Carolina Sta. Bul. 190; Washington Sta. Bul. 44; U. S. Fish Com. Rpt. 1902, p. 253; Report of the Commissioners on Fisheries and Game upon the Damage Caused to the Fisheries of Massachusetts by Dogfish during the Year 1905 (Boston, 1906, p. 61); Canada Expt. Farms Rpts. 1906, p. 158; Amer. Fert., 19 (1903), No. 6, p. 7; Ann. Sci. Agron., 3. ser., 1 (1906), I, No. 2, p. 166.

The product prepared from the menhaden is especially rich in fertilizing constituents, containing from 7 to 8 per cent of nitrogen and 6 to 8 per cent of phosphoric acid. The oil is removed from the menhaden and the material is prepared for use as a fertilizer by cooking in water in tanks heated with steam coils. This is the so-called process of tanking and is employed to remove the oil, which is a valuable commercial product, but interferes materially with the availability of the fertilizing constituents of the fish if not removed. The steaming also has a direct effect in increasing the availability of the phosphoric acid as well as the nitrogen of the fish. The boiling is continued until the oil rises to the surface and can be drawn off with the water, from which it is afterwards separated. The residue in the tanks is pressed in hydraulic presses, dried, and ground. In some cases the material is subjected after the first pressing to steam under pressure and to treatment with 5 per cent sulphuric acid to render the fertilizing constituents, particularly the phosphoric acid, more available.

The dry ground fish, or fish guano, obtained by this process is used to some extent directly as a fertilizer, but is usually mixed with other fertilizing materials (potash and phosphates) to make a better balanced complete fertilizer. The availability of the nitrogen in fish fertilizer prepared in this way is nearly as great as that of dried blood and tankage, which are considered among the best of the organic sources of nitrogen in fertilizers.[a] The phosphoric acid is also frequently more available than that in other organic matter.

Fertilizer prepared from fish waste from packing and canning establishments is more variable in its nitrogen content than that prepared from menhaden, owing to varying water content and proportion of bone, skin, and flesh in such waste. It is likely to be poorer in nitrogen and relatively richer in phosphoric acid than the menhaden product. According to Voorhees, the nitrogen in untreated fish scrap varies from 2.5 to 8 per cent and the phosphoric acid from 2 to 6 per cent, and these fertilizing constituents are much less available than in the tanked, dried, and finely ground material.

A large part of the fish offal accumulating at canneries and fish packing establishments, particularly in the Columbia River region and in Alaska, which might be profitably used, is now wasted, but steps are being taken to establish fertilizer factories for the utilization of this material in these regions. In regions where it can be readily obtained from fishermen, fish scrap and waste are frequently used without preparation of any kind. Various methods of composting and other simple processes of treating fish for use as a fertilizer have been used with more or less success on a small scale.

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[a] U. S. Dept. Agr., Farmers' Bul. 73, p. 7.

A report of the U. S. Bureau of Fisheries describes a method of composting as follows:

> A convenient process of converting a small quantity of refuse from dressing fish into fertilizer is to store it in a receptacle made in the ground. This should be about 5 or 6 feet deep, with the area depending on the amount of refuse, but usually about 6 feet square. It should be dry, and if the soil is sandy some clay should be spread at the bottom. First is placed a layer of wood ashes a few inches deep and then an equal layer of fish refuse covered by a sprinkling of lime. Then follow another layer of ashes, one of fish refuse sprinkled with lime, and so on until the hole is full. It should be covered with earth or sod and these covered with weighted boards and permitted to so remain for several months. The fish refuse quickly disintegrates and becomes mixed with the ashes, forming an excellent fertilizer.

It should be borne in mind in preparing such composts as this that the use of caustic alkaline substance such as wood ashes and lime in connection with easily decomposable organic matter, while admirably suited to the quick reduction of the material to a fine mechanical condition, is likely to result in the loss of a considerable amount of the nitrogen, which is the most valuable fertilizing constituent of the fish.

In the purchase of untreated fish and fish offal for direct use as a fertilizer farmers should be guided by the amount of water which it contains. Fresh fish and wet fish offal are very variable in water content, but probably contain on the average 50 to 60 per cent of water, with correspondingly lower percentages of nitrogen and phosphoric acid than the comparatively dry residue from oil extraction. It would hardly be profitable to transport such watery materials any considerable distance unless they could be obtained at a very low price. Voorhees states that if material of this kind containing 2.5 per cent of nitrogen can be obtained at $5 per ton it can be profitably used by farmers.

Fish and fish scrap have been successfully converted into fertilizer by simply drying and grinding. In this case it has been recommended to add a small amount of sulphuric acid (5 per cent) or muriate of potash to check offensive fermentation and to increase the fertilizing value of the resulting product. In Norway, which is one of the largest producers of fish fertilizer in the world, a common method is to spread the fish scrap on the rocks to dry, afterwards grinding it to the condition of a coarse meal. The Norwegian product is generally distinguished from the American fish fertilizer by its higher percentage of phosphoric acid and lower percentage of nitrogen.

Recently the possibility of utilizing the dogfish, which is proving so injurious to the fishery interests of the North Atlantic coast, for the manufacture of fertilizers, has been receiving considerable attention, especially by the Commissioners of Fisheries and Game of Massachusetts and the Department of Marine and Fisheries of Canada, and factories, notably one in Nova Scotia and two others in New Brunswick, have been established for this purpose under the auspices of the latter department. Analyses by F. T. Shutt, of the Canada Experimental Farms, of the products of these factories show a nitrogen content varying from 7.59 to 9.41 per cent and phosphoric acid from 2.94 to 6.49 per cent. The product is therefore of high value as regards nitrogen and phosphoric-acid contents. The samples examined, however, contained a very high percentage of oil (22.81 to 32.75 per cent), which seriously detracts from the fertilizing value of the product. There seems to be no insurmountable difficulty in the way of converting the dogfish into a high-grade fertilizer comparing favorably with the best forms of fish fertilizer, provided the dogfish can be supplied in sufficient amount to keep the factories running on an economical basis.

The foregoing statements, based upon a large amount of work by various experiment stations, make it plain that there is obtained from fish and fish waste a very valuable fertilizer, furnishing considerable percentages of both nitrogen and phosphoric acid, the former in readily available form. Fish fertilizer is especially valuable as a carrier of nitrogen either for direct use or in the preparation of mixed fertilizers. It should always be borne in mind that fish is deficient in potash and that in order to make a complete, well-balanced fertilizer it must be mixed with or used in combination with potash salts, and it is also improved by being reinforced with more soluble forms of phosphoric acid.

The following formulas are given by F. T. Shutt, of the Canada Experimental Farms, for combining fish with other fertilizing materials to make complete fertilizers for general use:

	Pounds.
For cereals and grass:	
Dry ground fish	300
Nitrate of soda	100
Superphosphate	300
Muriate of potash	50
Application—300 to 800 pounds per acre.	
For potatoes, roots generally, and clover:	
Dry ground fish	300
Nitrate of soda	50
Superphosphate	400
Muriate of potash	150
Application—300 to 800 pounds per acre.	

Dry sand or fine loam may be added to the mixed fertilizer to facilitate distribution. Probably the best plan of application is to broadcast the fertilizer on the thoroughly prepared land in the spring, previous to seeding, incorporating with he soil by one or more harrowings. It has been found that fish refuse gives the est returns on moderately light, warm, moist soils.

Like other organic manures, fish fertilizer is better suited to long-eason crops than to short-season, early-maturing crops. Favorable onditions for nitrification, which renders the nitrogen available to rops, are necessary to the greatest efficiency of the fish fertilizers, as f other organic nitrogenous fertilizers.

In experiments at the North Carolina Experiment Station, W. A. Withers found that while the rate of nitrification varied widely with he character of the soil, fish fertilizer in certain cases nitrified more apidly than sulphate of ammonia, dried blood, cotton-seed meal, and one. A warm, porous soil well supplied with lime is especially suited to the rapid nitrification of such manures as fish.

RECLAMATION OF SALT MARSHES.[a]

The New Jersey legislature in 1902 passed a bill providing, in a comprehensive way, for the locating and abolishing of mosquito-breeding salt-marsh areas, placing the management of the work in the hands of the entomologist of the New Jersey experiment stations. It was urged in favor of this bill "that in addition to the direct advantage to the State of the eradication of the mosquitoes, the indirect returns that would be derived from the drainage necessary in abolishing the mosquito-breeding areas would in a few years exceed the total appropriations asked for. This argument was based on the assumption that the water-logged marsh areas, now largely waste lands, would then grow instead grasses of commercial value. No definite statement could be made as to the area likely to be improved, nor its possible increase in value."

In order to obtain more definite information as to the benefits resulting from the drainage incidental to the mosquito extermination, as well as the possible benefits which might be derived from more thorough drainage, the executive officer in charge of the mosquito work was authorized to make such observations and investigations on the areas already drained as would serve as a basis for estimating the possible value to the State of such drainage work. In a recent report Prof. John B. Smith, the officer in charge of the mosquito work, summarizes his observations on this subject.

Three types of marsh lands were taken account of in his estimates of the possible increase of land values as a result of partial or complete drainage.

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[a] Compiled from New Jersey Stas. Bul. 207; U. S. Dept. Agr., Office of Expt. Stas. Rpt. 1906, p. 373; Circ. 76.

The first and smallest in area is that which is covered at every mean high tide and which may or may not be covered with sedge or joint grass. It is an area that has never been made useful for any purpose, is not dangerous as a mosquito-breeding territory, gradually rising or making up. It merges gradually into the second type.

The second type is in area rarely covered at ordinary tides, but so little above mean high water that even the slightest rise, due to wind, storm or moon changes, results in a watery covering. Such areas may be covered with sedge, but more usually have a scanty growth of the joint grass and are inhabited by fiddler crabs. This area is also without present value and is not dangerous as a mosquito breeder, for the burrows of the "fiddlers" provide effective drainage. Such marsh is usually very flat and level, and if holes occur they are of considerable size and naturally and continually stocked with fish and other marine organisms. This type of marsh is also gradually rising. The surface is quite generally a slippy mud, and there is not even shelter to tempt adult mosquitoes to rest on it.

The third type of marsh is all that area above mean high tide and more or less completely covered with vegetation.

These marsh lands have very little present value, although "all salt marsh of the third type may be made to produce an income of from $10 to $40 per acre annually, and all salt marsh of that type can be made of actual value. As a matter of fact, there are many hundred acres that do produce such incomes as against many times more that produce nothing—but can be made to do as well." Some of the higher lands produce a coarse hay which has some value for feed, bedding, packing, etc. Even the partial drainage carried out in the course of mosquito extermination has, in many cases, greatly increased the yield and improved the quality of the natural growth of hay.

Diking and drainage are the two recognized methods of reclaiming such marshes.

As to the relative cost of draining and diking and the cost of maintenance that is all in favor of the drainage. An average salt marsh can be drained for about $12 an acre, and on a large marsh area the average cost per acre of mosquito drainage is much less. The cost of maintaining the ditches need not exceed $1 per annum per acre and would probably be less. No effective diking could be done at any such rate, especially as, in any case, ditches would have to supplement it to get rid of the surface water. An area once diked and placed under cultivation can not be restored as a salt marsh for many years, if ever. A well-drained salt marsh may at its highest points be cultivated and used to produce such truck crops as will grow in salt land and is not in any way unfitted for later reclamation by diking.

A salt marsh properly drained for the production of maximum grass crop will not breed mosquitoes, because there will be no stagnant water on it anywhere. On the other hand, a mosquito-drained marsh may not be sufficiently drained for the production of maximum crops. In the mosquito work we are looking only to removing the excess of water and not to supplying water where there is none. A perfectly dry, high marsh area is untouched in the mosquito work, though it may be altogether too dry to produce the best grass crop

Therefore, while the effect of the work now in progress will be the material improvement of all the salt-marsh area treated, it will not result in the greatest possible improvement of all the marsh.

It seems evident from what has already been accomplished that a comprehensive plan of thorough drainage is not only feasible, but is economically advisable for a large proportion of these marsh lands which cover an area of over 296,000 acres in New Jersey. It is certain "that in the State of New Jersey there are at the present time thousands of acres of land capable of being put into shape to produce good, paying crops at a comparatively small outlay of money. The methods of doing this work are well known, have been sufficiently tried out, and are effective. The adoption of some scheme to secure this improvement will add at least $2,000,000 to taxable values within the State and should add at least $250,000 to the annual income of the owners of the lands."

In a publication of this Department[a] dealing with practical methods of reclaiming tide lands, Mr. J. O. Wright says of the importance and results of draining these lands:

> These waste places, rich in fertility and having an ample supply of moisture for plant growth, only need draining to enable heat and air to penetrate the ground to make them ideal locations for truck gardening on a large scale. Many of these are so situated as to offer economy in transportation which furnishes another important reason for their early reclamation. Either by rail or boat products can be landed cheaply and quickly in the market places of large cities or thriving towns at very little cost. This adds greatly to the commercial value of the land and allows for a much more liberal expenditure for its reclamation than could be borne if there had to be added to the cost of production the cost of a long-distance haul to market.
>
> About the only agricultural product grown on these lands in their native condition is marsh hay. This hay sells at present in the vicinity of Boston at $8 a ton. On areas which have been drained the hay sells for $25 a ton, and the yield per acre is larger than on the undrained tracts. The simplest form of improvement possible, therefore, increases the productive value of these lands threefold, but the greater part of the lands which have been reclaimed are too valuable for the growing of hay, and have been brought immediately into intensive cultivation. Cranberries are probably the most important crop at present grown on tide marshes. The area of cranberry bogs is being constantly extended and the trade in this fruit has assumed large proportions. Cranberry growing during the past two or three years has been quite profitable, and this has resulted in a marked activity in the extension of the area devoted to the crop and to the value of the lands reclaimed. Good bogs along the North Atlantic coast now sell for $1,000 an acre and pay a large return on this investment. The need of these marshes for truck farming is more apparent now than formerly because of the great increase in the number and population of some seaside resorts. Along Cape Cod and much of the Massachusetts coast the uplands have not the fertility needed for successful gardening. Much better results can be had from these marshes when drained than from the higher lands. In many places the

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[a] U. S. Dept. Agr., Office of Expt. Stas. Rpt. 1906, pp. 373-379.

growing of fresh vegetables in the immediate vicinity of town, requires the reclamation of marshes, and they are proving well adapted to this use. Asparagus grows with unusual vigor in such soil, and in places near Boston excellent crops are being produced where the marshes are occasionally flooded with sea water. Celery does excellently in some localities, but has failed, for reasons not well understood, in others. Cauliflower, cabbage, onions, muskmelons and watermelons, cucumbers, lettuce, sweet corn, field corn, potatoes, oats, redtop, timothy and alsike clover are all crops being successfully grown on reclaimed marsh lands along the North Atlantic coast; onions, celery, asparagus, cucumbers, and melons being the most profitable crops.

For many years the tide marshes of the South Atlantic coast were largely devoted to rice growing, and this is still the most important use of these areas, but changes in the flow of the rivers, which have taken place as the result of the removal of the forests and from other causes not so well understood, are bringing about a change in these lands, under which they are being more and more converted into truck farms. Asparagus, peas, potatoes, lettuce, beans, and cabbage are being raised in large quantities and shipped to the northern markets for sale early in the season. The products are of good quality, the business is proving profitable, and the area is being continually extended.

The drainage of swamp and marsh lands is a leading feature of the work of the drainage investigations of the Office of Experiment Stations of this Department, and the data already obtained in these investigations throw considerable light upon the cost of reclamation by drainage under various conditions, the causes of failures, and the best methods of procedure, and they have also attracted attention to the feasibility and advantages of such reclamation.

BERMUDA HAY.[a]

Some of the first experimental work begun by the Oklahoma Station was a series of grass-culture tests, which was subsequently extended into cooperative experiments with farmers throughout the State. The earlier results of this work[b] have shown that of the different grasses grown Bermuda grass alone possessed the requirements of a pasture grass for Oklahoma conditions, and more recent experience with this species also indicates its superior value for hay as compared with the wild grasses. The following brief report on the yield of Bermuda hay obtained at the station is of interest in this connection:

The 2½ acres of upland soil that was planted to hardy Bermuda grass on June 29 and 30, 1905, has been cut for the third time this season. The first cutting in the season of 1906 was made June 12. The total yield of cured hay from the field was 13,145 pounds, or at the rate of 5,658 pounds per acre. The second cutting for 1906 was made August 2. The rainfall from June 12 to the time of second cutting was 6.53 inches. Before the second crop was fully cured t began raining again and 5.36 inches of water fell on the hay before it was hauled in and weighed August 15. This thorough leaching reduced the weight materially, but the final weight of dry hay was 7,275 pounds from the 2½ acres, or 2,910 pounds to the acre. The third cutting was made September 18, and the hay cured without being rained upon. The total yield of cured hay for the field was 7,840 pounds, or at the rate of 3,136 pounds per acre.

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[a] Compiled from Oklahoma Sta. Rpt. 1907, p. 21.

[b] For previous article on this subject see U. S. Dept. Agr., Farmers' Bul. 251 p. 10.

The total yield of hay per acre for the season was 11,704 pounds or 5.08 tons. Land of the very same nature adjoining this field does not produce over one-half ton of prairie hay of inferior quality. Bermuda hay contains twice as much digestible nutrients as the best of prairie hay, is much more palatable, free from stems and weeds, and in every way superior to hay made from wild grasses. It is time Oklahoma farmers were beginning to wake up to the possibilities of this remarkable grass, not only as a pasture grass but also as a hay crop.

PROTEIN CONTENT OF FORAGE CROPS.[a]

VARIATION IN PROTEIN CONTENT.

Forage crops differ not only in yield or the number of tons of fodder produced per acre, but also in feeding quality or the quantities of valuable nutrients they contain. A comparative study of a large number of our common forage crops from this view point is reported by Prof. H. Snyder of the Minnesota Experiment Station. This investigator calls attention to the fact that by the use of more concentrated nitrogenous forage the amounts of the higher-priced grains and mill products generally employed in feeding may be decreased and, in consequence, a material financial saving effected. One of the most important constituents of all feeding stuffs is protein, and the most indigestible, and therefore the least desirable, constituent is crude fiber. It follows, therefore, that an increase in the protein and a decrease in the crude fiber content of forage crops is of great importance and value.

The observation was made in these investigations that forage crops when grown on well cultivated, fertile lands often contained from 25 to 30 per cent more protein and a smaller amount of crude fiber than when grown on poor soils. It is pointed out that a ration is not necessarily valuable in proportion to the digestible protein it contains, but that the important problem is the determination of the right combination of protein and carbohydrates that is to be fed to stock. Ordinarily the protein of the ration is supplied largely by the grains and the carbohydrates by the coarse fodders. It is stated that average forage crops furnish less than half of the protein of a mixed ration, and it is believed that more attention should be given to the production of forage crops of maximum protein content in so far as this is under the control of the farmer mainly by means of the kind of crop grown, the fertility of the soil, and the composition and character of the seed.

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[a] Compiled from Minnesota Sta. Bul. 101.

ALFALFA.

A comparison of analyses given shows the particularly high protein content of alfalfa, this being higher than that of clover and about twice as much as is found in timothy and prairie hay. Furthermore, alfalfa contains as much digestible protein as the average farm grains and mill products. Alfalfa also has the advantage of being cut at an earlier stage of growth than clover, which not only furnishes forage earlier in the season, but also tends to produce a fodder of a higher protein content.

CLOVER.

Clover is also one of the highest ranking protein producers among forage crops, and has the advantage that its culture is more familiar to farmers generally and that in many localities it is more easily grown than alfalfa. The number of cuttings, however, are in favor of the alfalfa crop when this is well established. Two crops of clover are usually produced each year, and the second is often considered to be better for feeding purposes. Analyses given show that in the samples studied the second cutting contained a little more protein and less crude fiber than the first, and in samples from another crop the first cutting was found to contain 12.6 per cent, while those from the second contained 16.43 per cent of protein. It was observed that the maximum protein and usually the minimum fiber are produced on soils fairly well supplied with lime, available potash, and phosphoric acid, and that soils with the highest nitrogen content did not necessarily produce clover richest in protein. White clover is rich in protein and is in general a valuable plant, but when eaten in large amounts by horses it is said to often cause an abnormal flow of saliva, and is for this reason disliked by many horse owners.

An examination of many samples of alfalfa and clover seed of known purity and uniform ripeness showed that some seeds were dark brown in color and others lighter and of a yellowish tinge. Analyses of these dark brown and yellowish seeds showed in some instances a quite pronounced difference in protein content, amounting to more than 5 per cent in favor of the dark brown seeds, while in some samples the difference was less than 1 per cent. The dark brown seeds uniformly contained more protein than the light yellow seeds, and it is believed that as in wheat and corn glutenous and starchy kernels have a decided tendency to produce grains of the same type, so in the case of alfalfa and clover high protein seeds will produce crops of maximum protein content, and that therefore seed selection for the purpose of increasing the protein content may be practiced with these crops as well as with the cereals. The results obtained showed that the physical characteristics of the seed indicate in a measure their chemical composition and offer a means of selecting alfalfa and clover seeds of high or of low protein content. These investigations suggest that for seeding preference should be given to the darker colored seeds of high germinating power.

PEAS.

Pea hay constitutes a valuable forage rich in protein, but its comparatively difficult cutting and curing is probably the cause of its limited use. While peas show as much diversity in color, density, and general physical properties as any seeds, a close examination will show two general types—yellowish and green seeds. Both types consist of individual seeds either darker or lighter in color. In eight hand-picked samples, each representing a different variety selected on this color basis, the protein content was found to range from 19.15 to 31.74 per cent. The darker colored and harder seeds contained 3.74 per cent more protein than the light colored seeds, which were richer in starch. This difference in the type of seed, as in the case of alfalfa and clover, is considered a factor valuable in the production of more protein in the pea crop.

SOY BEANS.

Samples of soy beans selected in the same way as the samples of peas showed a difference in protein content of 6.27 per cent in favor of the high protein type. A mixture of corn fodder and soy beans containing a larger proportion of soy beans than of corn fodder showed a protein content of 14.87 per cent, or about as much as is found in clover hay. The soy beans alone contained 19.82 per cent and the corn alone 9.54 per cent of protein.

RAPE.

The rape plant was also studied in this connection, and it was found that plants grown on manured land contained 4.61 per cent more protein than those grown on unmanured land. The statement is made that under average conditions the dry matter of rape contains as much protein as clover. While the separation of rape seeds into high and low protein groups is difficult on account of the lighter colored immature seeds, it was found, however, that when special care was exercised in the removal of immature seeds it was possible to select glutenous and starchy ones with a difference of over 1 per cent of protein in favor of the glutenous type.

CORN FODDER.

No forage is more easily grown or affords a larger amount of nutrients per acre than corn fodder. In dry matter content it ranges between wide limits, containing sometimes as high as 90 per cent of water when very green and only 15 per cent when mature and field cured. The dry matter of corn fodder when produced under the most favorable conditions on well tilled and fertilized land contains from 8 to 9 per cent of crude protein. In the sample studied a difference of 3 to 4 per cent in protein content is found in favor of corn fodder grown on well tilled and manured land over that grown upon similar but unmanured land. Attention is called to the fact that corn silage is quite variable in composition, depending largely upon the character of the corn at the time it is put into the silo. The average silage contains about 75 per cent water and 25 per cent dry matter. The dry matter usually contains from 6 to 10 per cent of crude protein and about the same per cent of other nutrients as fresh corn fodder. A chemical analysis of a sample of corn smut showed that this substance is richer in proteid and nitrogenous matter than the corn itself. Corn stover or the stalks and leaves after the grain is removed contained 7.10 per cent of crude protein in samples of good quality and 5.02 per cent in samples of poor quality.

BROME GRASS.

Bromus inermis has about the same general composition in feeding value as timothy hay, but as the fiber and nonnitrogenous compounds increase rapidly in the later stages of growth it requires early cutting in order to secure the highest feeding value. The dry matter of fresh pasture grass is characterized by a high percentage of protein, but the amount of water in this grass is also very high, ranging from 85 to 90 per cent. In many localities the use of grass-seed mixtures consisting of clover, timothy, redtop, and other grasses has been found more satisfactory and profitable than seeding with just one grass alone. This mixed herbage has a high feeding value, particularly when 25 per cent of the grass-seed mixture is clover. A mixed hay crop containing clover and growing on a well-manured and well tilled soil will contain from 10 to 12 per cent of crudé protein, and this is forage of a high protein class. In addition to being of a high protein value, such a forage is a good mechanical mixture and affords a variety in the ration.

OTHER FORAGE PLANTS.

The forage crops of high protein content, as clover, alfalfa, peas, vetch, soy beans, and rape, in field-cured or air-dried condition usually contain from 12 to 20 per cent of crude protein; while those of medium protein content, as corn

fodder, timothy, millet, blue-grass hay, prairie hay, and *Bromus inermis*, contain from 5 to 11 per cent. Because of this wide range it is evident why so much stress is laid upon the importance of forage of high protein content and why there is a saving of grain and mill products when such forage is used in the feeding of live stock.

The forage obtained from millet, rye, timothy, prairie grasses, corn, *Bromus inermis*, and pasture and meadow mixtures are classified as forage of medium and low protein content. Analyses presented show that the dry matter of millet when the crop has been properly grown has as much protein as timothy hay or corn fodder, but that when produced under poor conditions its protein value is low. It is shown that rye fodder contains about the same amount of crude protein as the best grades of timothy at the same stage of growth. Analyses of samples of timothy hay presented show a range in protein from 5.11 to 9.10 per cent. It was further noted that in the use of timothy hay from soil highly fertilized with barnyard manure 25 per cent more protein and less fiber were obtained than from that grown upon poor soil. If grown under the best conditions, timothy hay may contain as high as 9 per cent of crude protein and then may be classed as forage of a medium high protein content, but if grown under poor conditions and on poor soil it may contain less than 5 per cent of crude protein or not more than is found in the best grades of straw. Bright, mediumly fine high-grade prairie hay is shown to contain nearly 9 per cent of protein and coarse low-grade, overripe and bleached samples less than 5 per cent.

WEEDS.

Analyses of 18 samples of the more common weeds showed that many of them withdraw large amounts of nitrogen from the soil. The large amount of protein in the dry matter was particularly noticeable in purslane, lamb's-quarters or pigweed, and cheese weed or mallow. It is stated that there is more protein in the dry matter of these weeds than in either alfalfa or clover, and it is suggested that it is advisable to keep a few sheep on every farm for utilizing and controlling the weed crop in order that under such a system the land may be reclaimed and the weeds utilized for both forage and green manure.

The foregoing facts suggest that by judicious selection and simple methods of improving forage crops with reference to protein content the feed bills now made up so largely of expenditures for costly concentrated feeds to supply the deficiencies of farm feeds in protein may be greatly reduced.

QUALITY IN WHEAT.[a]

Wheat growers are especially desirous of varieties which are resistant to disease and which give a large yield; millers are particularly interested in the yield and quality of flour, and bakers in the appearance and character of the goods which the flour produces.

In discussing the quality of wheat, one has to consider both the miller's and the baker's point of view. These two are often confused, and the term "milling quality" or "milling value" is sometimes employed in the same sense as "baking quality." The miller desires primarily a large yield of flour of good appearance, while the baker is not directly interested in the yield, but requires the flour to be of such appearance and strength as will suit his particular purposes. It might happen, therefore, that a sample of wheat of excellent milling quality might yield flour quite unsatisfactory to the consumer, and on the other hand, a poor, somewhat shriveled sample of wheat might give a small yield of flour possessing admirable baking qualities.

In referring to flour, the terms "quality" and "strength" are often used as if they had the same significance, which is not strictly true. The term "strength" conveys a fairly definite idea, even though slightly different meanings may be attached to it at various times. "Quality," however, obviously signifies suitability for the purpose intended. A flour of high quality for pastry is a flour of low strength, whereas a flour of high quality for the production of very light bread or for mixing to improve the strength of weak flours must be of high strength.

Many tests designed to show quality have been devised, some of them simple and others very elaborate. In milling tests the weight of wheat per measured bushel and the percentage yield of flour of better grades are the important considerations. In baking tests the amount of water taken up by a given quantity of flour, the amount retained in the bread, the volume of the loaf, the form of crust, the texture and inside color of the loaf, the time of fermentation, and other similar factors are usually determined. With the data secured by such tests it is possible to so grade the flours that commercial requirements are met, for the majority of persons in purchasing bread disregard flavor, nutritive value, and digestibility and consider appearance only.

A number of the agricultural experiment stations in the United States have studied composition, particularly protein content, as related to yield, and milling quality of different varieties of wheat. Of late work may be mentioned the Virginia Experiment Station tests, reported by P. O. Vanatter, in which it was found that of a number of winter wheats Iron Clad had the highest protein content, namely, 17.20 per cent, while the lowest, 14.6 per cent, was found in Blue Ridge. Blue Straw Fultz, Fulcaster, and Mediterranean also had high protein content, the values found being 16.80, 16.73, and 16.72 per cent, respectively. Turkey Red did not give good results at the Virginia Station.

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[a] Compiled from Colorado Sta. Rpt. 1905, p. 24; Minnesota Sta. Bul. 102. Nebaska Sta. Bul. 89; Virginia Sta. Rpt. 1906, p. 50; Canada Cent. Expt. Farm Bul. 57.

At the Colorado Station, W. H. Olin in reporting the results of a study of the comparative value of different varieties of wheat states that Defiance was found to be the best spring wheat and Turkey Red the best winter wheat for milling purposes. In this and many other reports of experiment station work the relative yield of different varieties and the weight per bushel are factors which are also taken into account.

C. E. Saunders, of the Central Experimental Farm, Ottawa, Canada, has reported an extended study of the baking quality of a large number of varieties of wheat, this work being of great importance in connection with the studies which are being carried on at the Dominion experimental farms with a view to breeding new varieties of high quality. The samples were ground in an experimental mill and classified according to their milling qualities. The flour was stored under uniform conditions and the baking tests were elaborate and carefully made.

Of the numerous varieties tested Red Fife stood first in the two years' work as regards baking strength, volume, and shape of loaf, Laurel ranking lowest the first year and Grant and Ebert the second year. The following varieties yielded flour of high strength in the second-year tests, which were more extended than those carried on the first year: Bobs, Chelsea, Marquis, Early Russian, Gatineau, Haynes Blue Stem, Outlook, Hungarian White, Red Fern, and White Fife C. Professor Saunders states that Colorado, Herisson Bearded, and White Russian were of rather low strength and therefore not suitable for the production of extremely light bread or for export to countries desiring strong flour.

Of the winter wheats, included in the second year's work, Dawson Golden Chaff was rather low in strength, but produced good bread of pale appearance and rather compact character. Padi wheat the author considers unworthy of general cultivation, particularly on account of the greenish-yellow color of the inside of the loaf. Reference is also made in the report to the characteristics of other varieties tested.

As regards the effect of storage on quality, it was found that flour stored a year improved in every respect, " taking up a large amount of water, retaining more, giving a loaf of larger volume and of better shape, crust, texture, and color. The behavior of the dough in the oven was most remarkable. While in the first tests, with a water absorption of 59 per cent, the dough had a tendency to fall after the twelve-months keeping, although the water was increased to 62 per cent, the dough had the ability to rise to a most remarkable degree when put into the oven. The sample of flour was kept for the twelve months under dry conditions in a glass-stoppered bottle. It would appear that this astonishing change in baking strength must have been due to an improvement in the quality of the gluten, as it could scarcely be explained on any other supposition."

The author does not consider appearance a trustworthy indication of quality. "There is no doubt some justification for the preference of bright samples of grain, that is, those which are free from blemishes, usually caused by frost or rain; but it is quite uncertain in many cases to what extent the actual quality of the interior of the kernal has been lowered when there is evidence of injury to the bran. It is often highly probable that the interior of the berry is in essentially perfect condition even though the bran may be dull and unattractive."

In this connection it is interesting to note that T. L. Lyons and A. Keyser report that "yellow berries," which are chiefly due to allowing wheat to become overripe and failure to stack the sheaves, had a lower gluten content, though lighter in weight, than the red normal kernels of the hard winter wheat studied at the Nebraska Station.

Contrary to the opinion of some other investigators, Professor Saunders found that two flours mixed in equal proportions gave results in baking tests which were a very close average for the varieties used.

In the principal tests which were carried on at the Central Experimental Farm the bread was uniformly made with a large proportion of yeast. To determine whether this factor influenced quality, additional tests were made under other conditions, but none of the variations introduced materially changed the rank of the different flours as already determined.

Professor Saunders also studied the quality of flour when baking powder was used instead of yeast.

> All the flours tested produced biscuits of about the same volume, and though they differed somewhat in character and considerably in color the differences were not so striking as those observed in bread. It appears that almost any flour will make tea biscuits of fair quality. The experiments show that the flours tested had sufficient strength of gluten to attain the necessary volume when the gluten had not been subjected to the prolonged influence of the yeast fermentation and when the quantity of gas evolved was not very large, for it must be borne in mind that even a well-made tea biscuit has a small volume compared with that of a very light loaf of bread produced from the same quantity of flour. In spite of the similarity in conduct of the various flours under the conditions just mentioned, it is clear that one is not justified in concluding either that the gluten of all flours is practically identical or that the volume of a light loaf of bread is determined primarily by the quantity

of gas evolved. The making of ordinary tea biscuits can not be considered a est of the ability of gluten to withstand fermentation or of its power to retain a large quantity of gas produced inside the dough.

Two durum or, as they are often but less satisfactorily called, macaroni wheats were included among the varieties tested by Professor Saunders. The results which he obtained conclusively show, in his opinion, that the custom of regarding all such wheats as of one quality is absurd.

While the ordinary Goose (or Wild Goose) can not be recommended for bread making, the Kubanka produced admirable bread, which, however, differs in some ways from that produced from most of the other wheats. The Kubanka dough must be made rather stiff in order that it may not be too sticky to handle conveniently. It rises very well, producing a large loaf of very fine texture and of good form. The crust is somewhat unusual, being of a rich brown color and having a tendency to be thin and tough. The inside color of the bread is quite yellow, but this gives an appearance of richness and can only be objected to on the grounds of prejudice. Taking all its characteristics into consideration, * * * the bread produced from this sample of wheat was of excellent quality.

These conclusions are in accord with similar work reported from a number of the experiment stations in the United States.[a]

In a recent bulletin of the Minnesota Station, Prof. H. Snyder reports experiments which show quite conclusively that not only the variety, but also the method of fertilizing, may be an important factor in determining the quality for bread-making purposes of the wheat produced. He made chemical analyses and milling and baking tests of 41 samples of flour milled from wheat grown upon fertilized and unfertilized plats at nine different places. In 30 of the 41 tests the fertilizer which gave the largest yields per acre produced wheats of the highest bread-making quality. It appears, however, that while both yield and bread-making quality are improved by the use of fertilizers they are not necessarily improved to the same extent by the same fertilizer.

There appears to be no constant relationship between the percentage of protein n the grain and flour and the bread-making value, and while it is possible to ncrease the amount of proteids in flour by the use of nitrogenous fertilizers he bread-making value of the flour is not proportionately increased. In many stances the increase in nitrogen content imparts a negative value, as a part of he nitrogen is in nonproteid forms.

The experiments taken as a whole show that not only the yield of wheat, but also the bread-making value, can be enhanced by increasing the fertility of the soil, and that there is a very close relationship between the amount of available plant food in the soil and the quality of the wheat produced upon the soil and ts bread-making value.

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[a] U. S. Dept. Agr., Farmers' Buls. 186, p. 6; 251, p. 14. See also U. S. Dept. Agr. Yearbook 1903, p. 329.

The importance of composition and digestibility of wheat flour and other cereal products, the value of such foods in the diet, al various questions concerned with bread and bread making have be considered in earlier Farmers' Bulletins of the Department.[a]

DOES IT PAY TO SPRAY POTATOES?[b]

As stated in a previous bulletin of this series[c] the New York Stat Experiment Station has in progress in cooperation with grower different parts of the State a ten-year test of the profitablene spraying potatoes as a protection against diseases and insect p During each of the five years that these tests have now been carr on, spraying with Bordeaux mixture and arsenicals has proved useful and profitable practice. During the last of the five year ported upon to date, namely, 1906, the season "was in most par of the State the least favorable of any of the five for the developm of the principal potato disease, late blight and rot; yet in nearly of the 80 tests reported spraying gave good returns for the mo expended and labor applied."

The average net profit from spraying in 15 cooperative experim carried out during the season of 1906 was $13.89 per acre, the profit from similar experiments in 1905 being $20.04, in 1904 $24. and in 1903 $23.47.

"The highly favorable results obtained in the numerous exp ments made by the station and by New York farmers during the p five years should stimulate potato growers to give spraying a tr If it really is as profitable as these experiments indicate, they not afford to neglect spraying."

The following recommendations regarding methods of spray are made:

> In general, commence spraying when the plants are 6 to 8 inches high repeat the treatment at intervals of ten to fourteen days in order to keep plants well covered with Bordeaux throughout the season. During epidem blight it may be necessary to spray as often as once a week. Usually six ap cations will be required. The Bordeaux should contain 4 pounds of copper phate to each 50 gallons in the first two sprayings and 6 pounds to 50 gallo subsequent sprayings. Whenever bugs or flea-beetles are plentiful add 1 pounds of Paris green or 2 quarts of arsenite of soda stock solution to the q tity of Bordeaux required to spray an acre.
>
> Thoroughness of application is to be desired at all times, but is espe important when flea-beetles are numerous or the weather favorable to bl Using the same quantity of Bordeaux, frequent light applications are likel be more effective than heavier applications made at long intervals; e. g., s

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[a] U. S. Dept. Agr., Farmers' Buls. 112, 114, 192, 249. See also U. S. D Agr. Yearbook 1903, p. 347.

[b] Compiled from New York State Sta. Bul. 290.

[c] U. S. Dept. Agr., Farmers' Bul. 251, p. 9.

a horse sprayer carrying but one nozzle per row is used, it is better to go over the plants once a week than to make a double spraying once in two weeks. A good plan is to use one nozzle per row in the early sprayings and two nozzles per row in the later ones.

Those who wish to get along with three sprayings should postpone the first one until there is danger of injury from bugs or flea-beetles and then spray thoroughly with Bordeaux and poison. The other two sprayings should likewise be thorough and applied at such times as to keep the foliage protected as much as possible during the remainder of the season. Very satisfactory results may be obtained from three thorough sprayings.

A single spraying is better than none and will usually be profitable, but more are better. Spraying may prove highly profitable even though the blight is only partially prevented. It is unsafe to postpone spraying until blight appears. Except, perhaps, on small areas, it does not pay to apply poison alone for bugs. When it is necessary to fight insects use Bordeaux mixture and poison together.

The previous note on this subject referred to at the beginning of this article suggests that in order to secure economical and efficient spraying the growers might arrange for a "public sprayer," that is, some one man in a neighborhood who would make a business of spraying and would secure enough fields to keep him busy throughout the season.

USE OF ANESTHETICS IN FORCING PLANTS.[a]

Attention was called in a previous bulletin of this series[b] to the importance of controlling the dormant period of peaches, with special reference to preventing premature formation of buds and their subsequent destruction by frosts or freezing. Such control is now generally recognized as practicable with many plants and of value in their commercial production. Various means are employed to control the dormant period of plants, such as pruning, covering, attention to condition of growing wood in case of woody plants at the beginning of the period, and the like. In recent years attention has been turned to the use of anesthetics such as ether, chloroform, etc., for this purpose, especially with certain flowering and herbaceous plants. This method of treatment has been successfully practiced to some extent in Europe, but has not assumed commercial importance in this country.

Experiments by the Vermont Experiment Station with the use of ether in the forcing of rhubarb has been noted in a former bulletin of this series.[c] In a report of later experiments by this station along the same line, W. Stuart says:

The use of anesthetics as an aid in the forcing of flowering shrubs, tuberous and bulbous plants, and herbaceous perennials, has not as yet assumed com-

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[a] Compiled from Vermont Sta. Bul. 129; Rpt. 1906, p. 279.

[b] U. S. Dept. Agr., Farmers' Bul. 316, p. 6.

[c] U. S. Dept. Agr., Farmers' Bul. 233, p. 18.

> mercial importance among growers in this country. In Germany and Fran however, they are now used extensively in many of the large commercial establishments. Their use at the present time is almost wholly confined to flowering shrubs, such as lilacs, viburnums, deutzias, spireas, azaleas, etc., which le themselves most readily to anesthetic influences. This class of plants come in bloom early in the spring, complete their growth at a comparatively early date, and then pass into a state of rest. Normally plants will not start into grow until they have entered into the latter part of the rest period. The lar measure of success, therefore, in the use of anesthetics must necessarily co from plants subjected to the influence of ether or chloroform during the ear stages of rest.
>
> The process of treatment is a comparatively simple one. Plants which a either dormant or are entering into the stage of dormancy are subjected to t vapor of ether or choloroform in an air-tight room or receptacle for f twenty-four to seventy-two hours, depending upon the earliness or lateness the treatment and the temperature, the anesthetic being poured from above i an open vessel within the receptacle. The amount used per cubic foot of space is largely governed by the temperature, moisture, season of year, and k of plant to be treated. The higher the temperature and the later the se the more violent is the effect; hence the amount and time of exposure may said to vary inversely with the temperature and the season when treatme given. Apparently there is greater latitude in the amount that plants will s than is currently believed. The action of chloroform is much more intense that of ether, and only one-third to one-fourth the amount should be used.
>
> The relative increase in earliness of blooming period of treated over treated plants varies inversely to the earliness or lateness of the forcing per It is claimed that growth is hastened about a month by treatment. The amo of bloom is considerably increased thereby, but on the average a gain of fr ten to fifteen days is about all that may be expected.

As a result of his own experiments and of those of other investigators, Professor Stuart believes that "the anesthetization of flowering shrubs, such as lilacs, virburnums, azaleas, deutzias, spireas, etc., is a feasible and practical commercial enterprise for the florist." He found in his later experiments, as in the earlier, that etherization of rhubarb plants for winter forcing resulted in an increased yield, but that freezing of the rhubarb clumps at least early in the season, as is generally done in rhubarb forcing, is a necessary preliminary process, since etherization does not seem to perform the same function as freezing. He is of the opinion, however, that actual freezing may not be necessary for late forcing.

The action of ether on asparagus, potato tubers, apple, and palm seeds was also studied in the Vermont Station experiments.

> There seems to be some evidence of a responsive action on the part of asparagus to ether, but the results secured thus far are so inconclusive as preclude definite statement.
>
> Dormant potato tubers were treated similarly as was the rhubarb, but in case was there evidence of either beneficial or deleterious effect upon vegetati
>
> The etherization of apple seeds did not visibly accelerate germination; n from the data now at hand is there likelihood that any beneficial results w accrue from the etherization of palm seeds.

The use of anesthetics would seem to have some promise of practical value in the forcing of plants, especially as an aid in more completely controlling the period of maturing of the desired product, but undoubtedly many of the details of the practical applications of the method and the limits of its usefulness remain to be worked out.

FATTENING CATTLE FOR MARKET.[a]

In connection with extensive studies of problems concerned with fattening cattle for market, the Missouri Experiment Station has collected information from nearly 1,000 of the most successful cattle feeders in Missouri, Iowa, and Illinois, which represents experiences extending over periods of nearly twenty years and with an aggregate of approximately 2,000,000 cattle. The station has recently published a digest of these data and the results of the numerous experiments on a wide range of topics concerned with fattening cattle which have been carried on by the station.

In the opinion of Director H. J. Waters, who has compiled and summarized this information, methods which are based on the experience of successful men are in general satisfactory.

> The practical man in the long run arrives at correct conclusions on the main points involved in his practice. A theory that runs counter to the conclusions of men of long experience or to the principles of a long established practice should be well considered and should have the support of extensive and accurate experimental data before being accepted.

The duration of the feeding period is a matter of great importance in successful cattle feeding. As shown by the data collected from practical feeders, the average length of the full feeding period was one hundred and seventy-seven days, or practically six months. Little variation from this average was noted, and this factor seems to be fairly well established.

In Missouri the weight of the steer returning the greatest profit was 1,345 pounds, in Iowa 1,358 pounds, in Illinois 1,390 pounds, and in Nebraska 1,400 pounds, or on an average 1,367 pounds. In general 1,500 to 1,600 pound steers have not been profitable.

Cattle were put on full feed at 2 years of age by 40 per cent of the feeders and by 24 per cent at 2½ years of age.

> Evidently the corn-belt cattle feeder is not yet making baby beef. This is due to the fact that older cattle feed more uniformly, finish in a shorter time, and with less attention to the details of feeding. Of even more importance perhaps is the fact that older cattle may be bought as feeders with enough more margin than young cattle to make the feeding operation, on the whole, more profitable. It is furthermore shown that aged cattle are in somewhat better demand on the market, especially if somewhat underdone or of plain quality.

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[a] Compiled from Missouri Sta. Bul. 76.

In the matter of the most favorable season for fattening cattle, practical feeders consulted showed a decided preference for sum or at least for some season other than winter. The experiments wh Director Waters has summarized show that cattle gained much fas in summer than in winter and at about four-fifths the cost of wi feeding. It was also apparent that pigs following summer-fed ca made better gains and that less labor is required for feeding, haul manure, etc.

Gains are cheaply made on grass alone, but are low-priced, because the are not in marketable condition and must be sold as feeders with sufficient gin to enable the buyer to fit them for market.

The season of the year affects the market demand of cattle. Certain wei and classes are required for certain seasons, while other weights and cl will meet the best demand at other seasons. The steer that is staple th round is the thick-fleshed native, weighing from 1,200 to 1,400 pounds. class answers the demand of the dressed beef, the live export, the dead and the eastern shipper trade. Or, all classes of buyers use a greater number of these cattle throughout the year, making them staple at steady

Yearlings weighing 900 to 1,100 pounds when well finished and not offe too large numbers find a steady market and a good demand throughout the When plain in quality, or somewhat underdone, or when a little oversup the price declines sharply, because this class has a more limited use than dressed beef steer just described.

Three-year-old cattle weighing 1,500 to 1,600 pounds find a good demand hotel and resort trade the year round if not offered in too large numbers. demand is better one year with another from the latter part of the summe the 1st of December than at any other time for this class of cattle. They d need to carry so much quality or finish as yearlings or even dressed beef to sell at the highest price for their class.

A great variety of opinions were expressed as to the value of rou age in full feeding, though in general the data collected show feeders were indifferent as to the kind or quality of this part of th ration. Experiments conducted at the Missouri Station show coarse fodder decidedly affects the rate and cost of gain and the fi of the cattle. It has been found that with cattle bringing 5 cent pound corn combined with clover hay and cowpea hay was wo 8.25 cents more per pushel than when combined with timothy.

A large roughness consumption does not necessarily mean a diminished consumption. If the roughness be a legume hay, such as clover, or cowpea alfalfa, the amount consumed will be materially larger than when it is tim or corn stover, or prairie hay, or millet, and at the same time the cattle wil a larger amount of grain. The extra amount of protein in the legume hay the effect of stimulating a larger total consumption of feed, a considerable tion of which is grain.

As regards the value of shelter in full feeding, it is shown, as a result of years' experimental work, that steers on full feed gain more rapidly and what more economically when having access to an open shed, or even whe fined in an open lot, than when sheltered in a well ventilated barn.

There is a direct relation between the quality and condition of the feed ease and readiness with which cattle may be accustomed to it. Cattle

> gotten on full feed more quickly when coarse and relatively unpalatable material s used than when highly nutritious and well prepared feeds are used. * * *
>
> The amount of margin required to cover the expense of fattening and pay a profit is governed by a variety of circumstances. Younger cattle require a smaller margin than older cattle, because they make cheaper gains. Short fed cattle a smaller margin than long fed cattle, because the costs of gains is higher the longer cattle are on feed. Cattle of high quality require a narrower margin than cattle of poor quality because of the higher price at which they sell when finished. A larger margin is required in winter than in summer, because, it requires more feed to make a pound of gain. The higher the price of feed, the larger the margin required, unless the price of finished cattle has correspondingly increased.
>
> The farmers interviewed reported an average margin of $1.02 per hundred for a six months feed on 2-year-old cattle in the summer. It is estimated that for a similar feed in winter approximately $1.50 would be required.

It was apparent from the data collected that the average feeder gives comparatively little attention to the preparation of feed. About one-half of the feeders in Missouri, Illinois, and Iowa use ear corn exclusively, and if the feeders are included who use ear corn for part of the fattening period the proportion is much larger. Considering the data as a whole, shelled corn was fed dry either exclusively or at some season of the year by about 25 per cent of the feeders and corn-and-cob meal and ground shelled corn by less than 10 per cent on an average. A large number of the feeders made more effort to supply well prepared feed at the end of the fattening period than at the beginning or middle, with the object of maintaining satisfactory gains, as the feeding progressed, by catering to the appetite.

> At this time the system is loaded with fat and the maintenance cost per steer is very high; at the same time the appetite is variable and is disposed to decline. Anything, therefore, that tends to increase the amount of food consumed will affect favorably the rate and cost of gain.
>
> Better preparation is required in summer than in winter feeding, because the grass in summer is more palatable than the roughage used in winter, and for a large enough consumption of grain to produce a profitable gain it is required that the grain be palatable. Moreover, grain in summer is dry, hard, and more difficult to masticate, and is liable to have been somewhat fouled by mice and rats. These difficulties are in practice usually overcome by soaking the corn from twelve to eighteen hours.
>
> Better preparation of grain is required for young cattle than for aged animals, in order to stimulate the most rapid possible gain. This is necessary to finish the younger animals within a reasonable time. They use so large a proportion of their food for growth that a high rate of gain is necessary to make them fat quickly.
>
> The real reason for preparing grain for cattle is not to reduce the proportion of grain passing through the animal undigested, but rather to increase the rate of gain. This is so because whatever part of the grain the steer fails to utilize the hogs which follow the cattle will utilize to good advantage.
>
> The feeder is interested primarily in the aggregate gain of steer and hog per unit of grain fed, and can not afford, under the ordinary farm conditions,

to invest much labor and money in the preparation of feed which increases the steer gains wholly or mainly at the expense of the hog gains. So long as the food is offered in palatable enough form to make the steer gain at a rapid rate and make him fat in a reasonable time, the feeder is not interested in how much passes through the steer unmasticated or undigested, because the hog will make good use of it.

Taking the average price of all fat hogs and all the fat steers sold on the Chicago market for the past twenty-four years, it has been found that the hogs have brought a higher price per pound. It will be accepted without argument that less food is required to make a pound of gain on hogs than on cattle. As a rule, therefore, the hog end of the cattle feeding operation is more profitable than the cattle end.

The number of hogs required to utilize the waste per steer will vary greatly with the character of the feed, the way in which it is prepared, and with the size and age of the cattle. The range would be * * * at the rate of two to three hogs per steer on snapped ear corn, perhaps one and one-half on husked ear corn, about one on shelled corn, and from one-third to one-half a hog on crushed or ground corn.

Whatever factors favor rapid and profitable gains on cattle, excepting the better preparation of the feed, are liable to be favorable to the hog that follows. For example, hogs make better gains following cattle fed on clover or cowpea or alfalfa roughness with corn than they do when the roughness is timothy, millet, or sorghum. Likewise there is a material benefit to the hog by feeding the steer a limited amount of linseed meal. There is also a benefit to the hog from feeding cotton-seed meal to the steer, although it is less marked than when linseed meal is used.

It is almost as profitable to use a supplemental feed like tankage or linseed meal for hogs that are following cattle as for those that are being fed on farm grain. Especially is this true of hogs following cattle fed on straight corn with timothy or stover for roughness in winter or blue grass or timothy pasture in summer. Likewise a clover, alfalfa, cowpea, or soja-bean pasture for hogs following cattle will affect just as favorably the profits as though the hogs were not following cattle. In view of the fact that a considerable part of the profit of steer feeding is in the hog gains, it is important that most careful attention be given to the hogs, in order that the maximum gain may be secured.

An abundant supply of pure water convenient to the feeding bunks and in the grazing grounds is absolutely imperative. It is fatal to good results to require the cattle to travel long distances to water or to drink from ponds or troughs that are befouled by hogs or other stock. A steer on full feed and under the strain of rapid production requires a large quantity of water daily.

Cattle that are being fattened should be fed with the utmost regularity, should be kept as quiet as possible, and should be encouraged to lie down when not eating. They should never be frightened or disturbed in any way.

Changes in feed, location, or surroundings of cattle that are fat should never be made, except such as are decidedly for the better, and even then should be made only when most imperative.

COTTON-SEED MEAL AND CORN SILAGE FOR DAIRY COWS.[a]

John Michels and J. M. Burgess, of the South Carolina Station, state that "there is a prevailing belief that when cotton-seed meal is fed for long periods in quantities exceeding 4 pounds per cow daily he health of the animals will be more or less injuriously affected," ut in a series of experiments which they report it was found that otton-seed meal may be fed in conjunction with good corn silage to he extent of from 5 to 6 pounds per cow daily without affecting the ealth of the animals. Indeed such a ration appeared to keep the ows in an unusually good state of health. A ration consisting of otton-seed meal and good corn silage was consumed by the cows with great relish, which was in no way lessened when the feeding of such ration was continued for a period of five months.

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[a] Compiled from South Carolina Sta. Bul. 131.

> No bad effects were noticeable from the practice of feeding cotton-seed meal nd corn silage separately. On the contrary, such a practice appears to have istinct advantages over the common practice of mixing the meal with the oughage. Our results, therefore, tend to disprove the prevailing belief that eavy concentrates like cotton-seed meal will act detrimentally on the health f cows when fed unmixed with more bulky feeds.
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> Cows fed exclusively on cotton-seed meal and corn silage for a period of five months exhibited no craving for dry roughage, but always preferred silage to ood hay.
>
> According to the herd records, the cows yielded more milk and butter fat uring this experiment than during any corresponding period in previous years. Cotton-seed meal and rich, well matured corn silage constitute an excellent ration for cows yielding from 20 to 30 pounds of milk daily.

These results are of special importance because cotton-seed meal and corn silage form by far the cheapest dairy feeds available to dairymen in South Carolina and elsewhere in the South. It is stated that the cost of such a ration is only slightly more than half that of the common dairy ration now fed in the State.

The good results obtained in these experiments in the exclusive feeding of cotton-seed meal and corn silage as a dairy ration was attributed largely to the fact that the corn silage was made from well matured corn rich in grain, making it especially rich in carbohydrates, for it is explained that unless silage is especially rich in grain ration consisting entirely of corn silage and cotton-seed meal will e deficient in nonnitrogenous matter (carbohydrates).

It is believed that "with cotton-seed meal furnishing an unusually heap protein supply, and with the great yields of corn possible in this State * * * milk can be produced as cheaply, if not more heaply, in South Carolina than in any other portion of the world."

CARBONATED MILK.[a]

L. L. Van Slyke and A. W. Bosworth, of the New York State Station, report that in making a study of the chemical changes which occur in koumiss made from cows' milk it was noticed that lactic ac formed much more slowly in the koumiss than in ordinary mi This was found to be due to the action of carbon-dioxid gas und pressure.

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[a] Compiled from New York State Sta. Bul. 292.

A series of experiments was therefore undertaken to ascertain t effect of carbon dioxid under different pressures upon the devel ment of lactic acid in milk. These experiments were made with (fresh separator skim milk, (2) fresh whole milk drawn and handl under good hygienic conditions, (3) fresh skim milk pasteurized a 185° F., and (4) fresh whole milk pasteurized at 185° F.

The best results were secured when newly pasteurized milk or cleanly dra fresh milk was treated with carbon dioxid in a tank, such as is used in bot establishments in preparing carbonated drinks, and then placed in siphon bo tles. When charged under pressures of from 70 to 75 pounds and kept at te peratures ranging from 35° to 60°, bottles of clean fresh milk or pasteur milk kept from four to five months without perceptible increase in acidity.

Milk carbonated under a pressure of 70 pounds comes from the bottle a foamy mass, more or less like koumiss that is two or three days old. It ha slightly acid, pleasant flavor, due to the carbon dioxid, and has a somewh more salty taste than ordinary milk. In the case of carbonated milk pas ized at 185° F., there is, of course, something of a "cooked" taste. Though cream separates in the bottle, it is thoroughly remixed by a little shakin the milk comes from the bottle, and there is no appearance of separate pa cles of cream. All who have had occasion to test the quality of carbo milk as a beverage agree in regarding it is a pleasant drink. In the ca milk bottled under a pressure of 150 pounds of carbon dioxid, the milk de ered from the siphon is about the consistency of whipped cream, but on sta ing a short time it changes into a readily drinkable condition.

Carbonated milk furnishes a pleasant beverage, and it is sugges that it may find practical use as a healthful drink and as a valua food for invalids and children in cases where ordinary milk does no digest well.

It is pointed out that in order to prepare carbonated milk succes fully "the milk should be drawn so as to be as free as possible fro dirt, and promptly cooled below 45° F. It should be carbonat within a few hours. All the vessels with which the milk come contact, from milking to bottling, should be carefully sterilized be fore use. In case milk can not be carbonated quite promptly aft drawing, it should be thoroughly pasteurized before being charg and bottled."

PRESERVATION OF FENCE POSTS.[a]

As H. F. Weiss in a recent circular of the Forest Service of th Department points out, it is each year becoming more difficult t secure satisfactory fence posts, and since substitutes such as forced concrete and iron are probably too costly to compete with wooden posts, the only solution of the difficulty lies in the use of cheaper woods and in preventing decay by preservative treatment.

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[a] Compiled from Wyoming Sta. Bul. 75; Rpt. 1897, p. 29; U. S. Dept. Ag. Forest Service Circ. 117.

A great variety of preservative treatments have been tried with varying success. B. C. Buffum, of the Wyoming Experiment Station, reports that he has been able to preserve pitch-pine posts with but little injury for sixteen years by dipping the lower ends of the posts in crude petroleum to a sufficient distance to come above the ground line when the posts are set, and burning off the oil. He states that "this dipping can be done very cheaply and will undoubtedly pay. A second method is to simply dip 2½ feet of the bottom of the posts in crude petroleum or in tar; this did fairly well. The oil seemed a better protection to the posts than did the coal tar. Posts that were well charred by burning came in about third place. * * *

There is little advantage to be gained by simply oiling or tarring a band to protect the post from dry rot where it comes through the ground, and less from any treatment of only a portion below the ground. Such oil band helped preserve the post, but the time taken to apply the oil in this manner would make it more expensive than dipping the entire lower end of the post.

The Forest Service has made a very careful study of the subject of preservation of posts, and has obtained the most satisfactory results on the whole with the creosote treatment. The chief merit of this treatment is that it renders inferior woods as serviceable as those of better quality, thus saving the latter for other purposes and aiding in conserving the rapidly diminishing supply of the more valuable woods.

The process of treatment with creosote has been greatly cheapened by what is known as the "open-tank" method introduced by the Forest Service. It is stated that the necessary equipment for this treatment can be installed at a cost of from $30 to $45, or for much less if an old boiler is used. The essential requirements are that the creosote shall be heated to about 215° F. and that the butts of the posts shall be submerged up to about 6 inches above their ground line. A tank with a bottom 12 square feet in area has been found of sufficient size for treating forty to fifty 6-inch posts a day, or double that number when two runs per day can be made, as is possible with lodgepole pine posts. The amount of creosote absorbed was found in the Forest Service experiments to vary from one-tenth gallon with Eucalyptus posts to seven-tenths gallon with sycamore, cottonwood, and lodgepole pine. At the time these experiments were made the price of creosote varied from 10 cents per gallon in the East and Middle West to 27 cents per gallon in the Rocky Mountain States, and was about 16 cents per gallon on the Pacific coast. On the basis of these figures it is estimated that the cost of treating a post varied from [illegible] to 15 cents.

In experiments with the preservative treatment in Idaho it was found that the durability of lodgepole pine posts was increased [illegible]teen years. On this basis, and notwithstanding the high price of creosote in Idaho, it is estimated that by treating the posts there was a saving with interest at 6 per cent of 2 cents per post yearly. It is pointed out that since the resistance of all treated posts to decay is alike regardless of the kind of wood only the cheaper kinds of wood should be used for posts, and, further, that as sapwood is more readily impregnated with creosote than heartwood, posts containing much sapwood are to be preferred to those which are largely of heartwood. It is quite important that the posts should be air dried before they are treated or set. "They should be cut at least a month before treatment. Wood dries fastest in spring or summer, but with those species which check badly, such as the oaks, cutting is best done in autumn or early winter."

Both the inner and outer bark should be completely removed before treatment. Round posts are, as a rule, preferable to split posts.

If butt treatments in the open tank can not be given, and yet some preservative method is desired, plunge the butts of the posts into a vessel of hot creosote or carbolineum or apply either liquid with a brush. A long bath in hot creosote, followed by a shorter one in cold creosote, will probably give best results. Usually woods with a porous structure, like the poplars, can be treated more easily than dense woods, like the oaks, and hence need not be left in the creosote for so long a time.

The tops of posts should be cut slanting, preferably with an ax, so that the rain will not remain on them. If cut with a saw the pitch should be greater.

Setting posts small end downward has no effect in checking decay.

There is some advantage from piling stones around the base of the posts or setting them in masonry or concrete, but not enough to justify the cost.

Charring the butt of the post, if properly done, gives good results. The posts in this case should be thoroughly dry and the charring should extend at least 6 inches above the ground line.

Soaking posts in solutions of copper sulphate or mercuric chloride is not considered a practical method of treatment.

Good results, particularly with soft woods like sycamore and cottonwood, have sometimes been obtained by boring holes diagonally into the posts just above the ground line and filling them with some preservative solution, such as various forms of coal tar, but it should be borne in mind that the posts are weakened by the boring of such holes.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 321.

THE USE OF THE SPLIT-LOG DRAG ON EARTH ROADS.

BY

D. WARD KING.

WASHINGTON:
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1908.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF PUBLIC ROADS.
Washington, D. C., March 17, 1908.

SIR: I have the honor to transmit herewith a manuscript by Mr. D. Ward King, an expert in this Office on the split-log drag, which gives directions for the construction of the split-log drag and its use on earth roads. It contains information which will be of practical value to a large number of readers, and I therefore respectfully recommend that it be published as a Farmers' Bulletin.

Respectfully,

LOGAN WALLER PAGE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE USE OF THE SPLIT-LOG DRAG ON EARTH ROADS.

INTRODUCTION.

The earth road is by far the most common type of highway in this country. Its cheapness in comparison with other types of construction and the absence in many sections of the country of rock, gravel, or other hard natural materials for road building will render its use necessary for many years to come.

There are at present in this country about 2,000,000 miles of such roads, most of which must be maintained by some means more or less inexpensive. The split-log drag is of great service on roads of this class, and an increasing mileage of the rural highways of this country is being kept in repair economically and well by the use of this simple implement. It is now in use in many States of the Union and in foreign countries also, and its adoption in most localities where there are earth roads will doubtless increase.

The aim in writing this bulletin has been to give a concise description of the construction of the split-log drag and the method of using it which will give the best results. The ditch cleaner, another useful implement for use on earth roads, has also been briefly described.

THE CONSTRUCTION OF A SPLIT-LOG DRAG.

The author has experimented with a great variety of devices for road dragging, but has found the two-slab log or plank drag with liberal "set back" the most satisfactory. Double drags for working both sides of the roadway simultaneously have been tried with only limited success. The reason for this lies in the fact that both sides of an earth road are never exactly alike. This causes the two parts of the drag to work unevenly and to interfere with each other. It is also impossible for one man to operate both parts successfully, as will be shown later on.

Two mistakes are commonly made in constructing a drag. The first lies in making it too heavy. It should be so light that one man can easily lift it. Besides, a light drag responds more readily to various methods of hitching and to the shifting of the position and weight of the operator, both of which are essential considerations and are discussed more fully under the head "How to use a drag" (p. 9). A drag can be made heavier at any time by proper weighting.

The other mistake is in the use of squared timbers, instead of those with sharp edges, whereby the cutting effect of sharp edges is lost and the drag is permitted to glide over instead of to equalize the irregu ities in the surface of the road. These mistakes are due partly badly drawn illustrations and plans of drags which have occasion appeared in newspapers and partly to the erroneous idea that i necessary that a large amount of earth shall be moved at one ti

A dry red cedar log is the best material for a drag. Red elm a walnut when thoroughly dried are excellent, and box elder, s maple, or even willow are preferable to oak, hickory, or ash.

The log should be 7 or 8 feet long and from 10 to 12 inches in di eter, and carefully split down the middle. The heaviest and b slab should be selected for the front. At a point on this front sla inches from the end that is to be at the middle of the road locate t

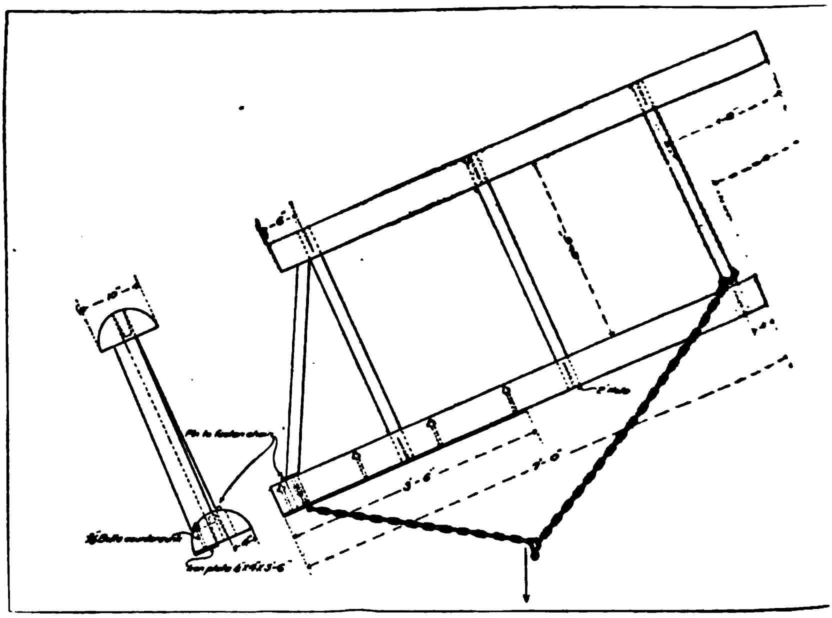

Fig. 1.—Plan and elevation of split-log drag.

center of the hole to receive a cross stake and 22 inches from the ot end of the front slab locate the center for another cross stake. T hole for the middle stake will lie on a line connecting and halfw between the other two. See figure 1. The back slab should no placed in position behind the other. From the end which is to be the middle of the road measure 20 inches for the center of the cr stake, and 6 inches from the other end locate the center of the out stake. Find the center of the middle hole as before. When th holes are brought opposite each other, one end of the back slab w lie 16 inches nearer the center of the roadway than the front o giving what is known as "set back." The holes should be 2 inche diameter. Care must be taken to hold the auger plumb in bor hese holes in order that the stakes shall fit properly. The hole to eceive the forward end of the chain should be bored at the same time.

The two slabs should be held 30 inches apart by the stakes. Straight-rained timber should be selected for the stakes, so that each stake hall fit snugly into the 2-inch hole when the two slabs are in the roper position. The stakes should taper gradually toward the ends. here should be no shoulder at the point where the stakes enter the lab. The stakes should be fastened in place by wedges only.

When the stakes have been placed in position and tightly wedged, brace 2 inches thick and 4 inches wide should be placed diagonally o them at the ditch end, as shown in figure 1. The brace should e dropped on the front slab, so that its lower edge shall lie within an nch of the ground, while the other end should rest in the angle etween the slab and the end stake.

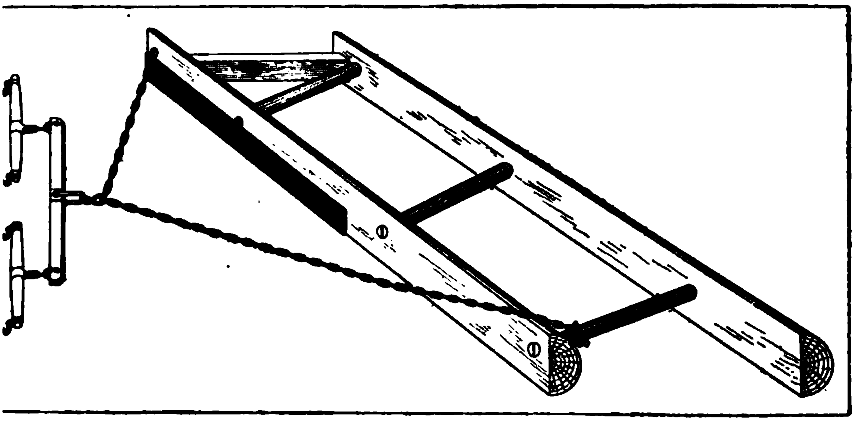

Fig. 2.—Perspective view of split-log drag.

A strip of iron about 3½ feet long, 3 or 4 inches wide and ¼ of an inch thick may be used for the blade. This should be attached to the front slab, so that it will be one-half inch below the lower edge of the slab at the ditch end, while the end of the iron toward the middle of the road should be flush with the edge of the slab. The bolts holding the blade in place should have flat heads and the holes to receive them should be countersunk.

If the face of the log stands plumb it is well to wedge out the lower edge of the blade with a three-cornered strip of wood to give it a set like the bit of a plane.

A platform of inch boards held together by three cleats should be placed on the stakes between the slabs. These boards should be spaced at least an inch apart to allow any earth that may heap up and fall over the front slab to sift through upon the road again. The end cleats should be placed so that they will not rest upon the cross stakes, but drop inside them, while the middle cleat can shifted to either side of the middle stake. These cleats should exte about an inch beyond the finished width of the platform.

An ordinary trace chain is strong enough to draw the implemen provided the clevis is not fastened through a link. The chain shou be wrapped around the rear stake, then passed over the front sl Raising the chain at this end of the slab allows the earth to drift pa the face of the drag. The other end of the chain should be pas through the hole in the end of the slab and is held by a pin pas through a link. One and one-half trace chains are sufficient.

In many logs the grain runs around the tree in such a way t when split the slabs will be in a "wind." If this wind is not m

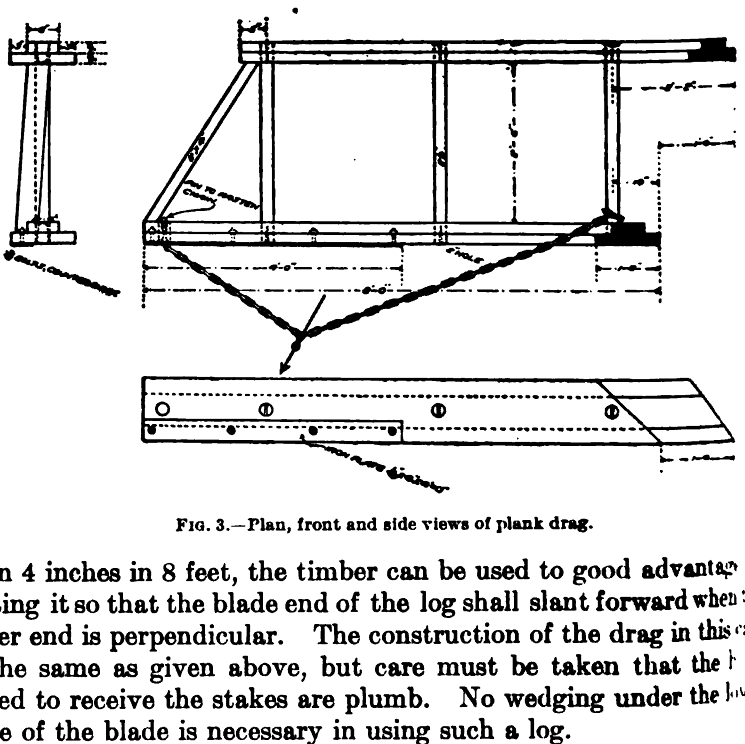

Fig. 3.—Plan, front and side views of plank drag.

than 4 inches in 8 feet, the timber can be used to good advanta setting it so that the blade end of the log shall slant forward when other end is perpendicular. The construction of the drag in this is the same as given above, but care must be taken that the h bored to receive the stakes are plumb. No wedging under the lo edge of the blade is necessary in using such a log.

Drags are often constructed of planks instead of logs. There nothing in the construction of a plank drag that calls for particu mention except the strengthening of the planks along their mid line by a 2 by 6 inch strip, as is shown in figure 3. A triangular st may be used under the lower edge of the blade to give it the prop cutting slope.

HOW TO USE A DRAG.

The successful operation of a drag involves two principles, which when thoroughly understood and intelligently applied, make road working with this implement very simple. The first concerns the length and position of the hitch, while the second deals with the position of the driver on the drag. Each influences the other to a large extent, and successful manipulation of the drag is dependent upon an understanding of both of them.

For ordinary purposes the snatch link or clevis should be fastened far enough toward the blade end of the chain to force the unloaded drag to follow the team at an angle of 45 degrees. This will cause the earth to move along the face of the drag smoothly and will give comparatively light draft to the team, provided the driver rides in the line of draft. Sometimes, however, conditions are met which require special treatment, and in a rolling country such conditions are not infrequent. Often a flat place several rods in length or a seepy spot needs special attention.

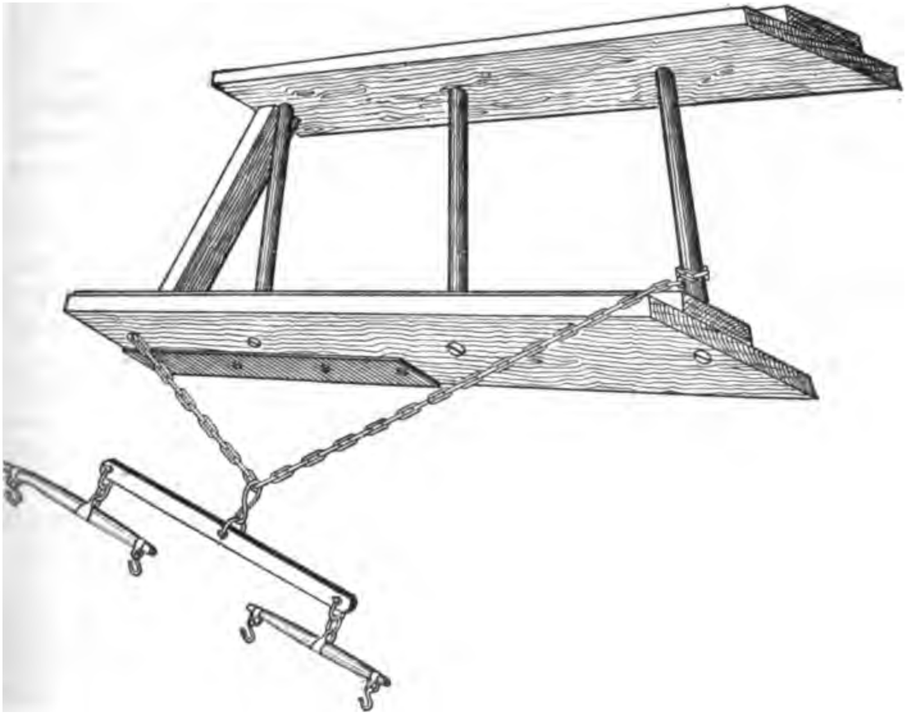

Fig. 4.—Perspective view of plank drag.

The distance from the drag at which the team is hitched affects the depth of the cutting. Shortening the chain tends to lift the front slab from the ground; a longer hitch causes the blade to cut more deeply. The length of hitch may be regulated by lengthening and shortening the chain at the end which runs through the hole in the blade end of the drag.

If small weeds are to be cut or a furrow of earth is to be moved, the doubletree should be attached rather close to the ditch end of the drag. The drag will now move nearly ditch end foremost, and the driver should stand with one foot on the extreme forward end of the front slab. This will swing the drag back to the proper angle and will cause the blade to plow. This hitch requires slow and careful driving in order to prevent the drag from tipping forward. If the blade should plow too deeply, as it may do in a wet spot, the driver should shift his weight toward the back slab.

If straw and weeds clog the blade, they can usually be removed if the driver shifts his weight to a point as far as possible from the ditch or blade end. Similarly, if he steps quickly away from the ditch end, the load of earth may be dropped into a low place or mudhole.

Some attention should be given to the edge of the blade. In the beginning, the average earth road requires no steel plate on the drag, though the drag will be better preserved if the steel is applied at first. At the end of a year's work, if the dragging has been faithfully done, a steel plate will be needed. If the twist of the log is properly used, or the three-cornered strip of wood is placed under the blade as described on page 7, a flat piece of steel will answer. In case the blade stands perpendicularly it should be slightly cupped when sharpened.

Usually two horses are enough to pull a drag over an ordinary earth road. When four horses are used, they should be hitched to the drag by means of a four-horse evener. The team should be driven with one horse on either side of the right-hand wheel track or rut the full length of the portion to be dragged, and the return made over the other half of the roadway.

The object of such treatment is to move earth toward the center of the roadway and to raise it gradually above the surrounding level. While this is being accomplished, all mudholes and ruts will be filled into which traffic will pack the fresh earth.

WHEN TO USE A DRAG.

The drag does the best work when the soil is moist, but not sticky. The earth then moves freely along the faces of the slabs. If the roadway is very badly rutted and full of holes, it may be well to use the drag once when the ground is slushy. This treatment is particularly applicable before a cold spell in winter when it is possible to have a roadway freeze smooth.

A smooth road surface is secured by this method. Clay, when nixed with water and thoroughly worked, becomes remarkably ough and impervious to water. If compacted in this condition t becomes extremely hard.

Another valuable result of dragging is the reduction of dust, for he particles of clay cohere so tenaciously that there is but little wear vhen the surface is smooth. Dust on an earth road is due to the reaking up under traffic of the frayed and upturned edges of ruts nd hoof prints. If the surface is smoothed after each rain and the oad dries hard and even, no edges are exposed to crushing and the nly dust which forms is that due to actual wear of the road surface.

There are so many influences at work and conditions are so varied n different localities that it is quite impossible to lay down a general ule for the number of treatments needed to keep a road in good condition. A tough clay or a stiff sandy clay will resist the action of wheels and hoofs for a longer period than a loam, other things being equal. Certain sections of a roadway will require more attention than others because of steep grades, seepage, exposure to hillside wash, etc. The best guide in meeting these conditions is the knowledge and experience gained while dragging the roadway.

There is one condition, however, in which special treatment should be given to a road. Clay hills under persistent dragging frequently become too high in the center. To correct this it is best to drag the earth toward the center of the road twice and away from it once.

USE OF A DRAG ON ROCKY OR GRAVELLY ROADS.

In soils full of loose stones or even small bowlders the drag has done good service. The loose stones are drawn into a windrow down the center of the road while the earth is deposited around the bowlders in such a way that the surface is leveled. The loose stones in the center of the road should of course be removed. Where there is a large proportion of small stones or gravel the drag will keep down the inequalities in the surface.

COST DATA.

There is little available data on the cost of maintenance of earth roads by dragging. However, there is no doubt as to the economy of the drag, either in first cost or in its operation. The most elaborate form will cost but a few dollars for material and labor, while one man and team can operate it successfully under all usual conditions. As a consequence, the statements given below are well within reason and indicate what may be accomplished with a very small outlay.

The following figures show the cost of maintaining ordinary country roads per mile per year without a drag, and may be taken as a basis of the cost of such maintenance. They were obtained in Kansas by Prof. W. C. Hoad, of the University of Kansas, in 1906, and were taken from the official records of the counties:

Crawford County	$52
Douglas County	38
Franklin County	34
Johnson County	48
Neosho County	40
Saline County	43

The average cost is $42.50 per mile per year, and it may safely be said that the cost of dragging would be trifling in comparison.

Mr. F. P. Sanborn[a] states: "The least expense per mile [for dragging] was about $1.50; the greatest a little over $6; the average expense per mile for 5½ miles a little less than $3." Commenting further, Mr. Sanborn declares: "The writer has lived by this piece of road all his life, and although we have had the extremes of weather this season, both wet and dry, not for forty years has the road in question been so free from mud and dust. Parties who have known the road all their lives are agreed that it never was in so good condition a season through."

When Mr. R. H. Aishton, general manager of the Chicago and Northwestern Railroad, investigated the work of the split-log drag at Sac City, Iowa, preliminary to the campaign inaugurated by that company in 1905, he learned that one township had experimented with the drag on 28 miles of highway, for a year. He found that the township paid for the making of the drags and hired men to use them, including the original cost of the drags when figuring the expense of the year's work. The total expense for the twelve months averaged $2.40 per mile, and the roads were reported to have been "like a race track" the larger portion of the year.

A neighborhood of farmers in Ray County, Mo., employed one of their number to drag a 5-mile stretch. He received compensation at the rate of $3 per day. When the end of the year came and a settlement was made, the cost for the year was found to be $1.66 per mile. The road is a tough clay and my informant declares it was always much better than the other roads in the neighborhood.

Prof. William Robertson, of the Minnesota Agricultural Station, after a year's experience in dragging a "main road made entirely of gumbo without any sand or gravel, and which during the past year has shown no defects either by rutting or development of soft places," fixes the cost of the work at not to exceed $5 per mile.

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[a] Report of Highway Commissioner of Maine, 1906, p. 112.

CONSTRUCTION AND USE OF A DITCH CLEANER.

The ditcher or ditch cleaner is a convenient device for clearing ditches. It consists of a guide plank, 2 inches by 12 inches by 12 feet, and a mold board, 2 inches by 12 inches by 8 feet. These are braced with a crosspiece 3 feet long as shown in figure 5. The mold board should be shod with an iron plate ¼ inch by 4 inches by 3 feet, held in position with ¾-inch bolts countersunk. The cross brace should be hollowed 3 inches on each side at the middle, the hollowing to begin not less than 4 inches from each end, in order that its bearing against the guide and mold board planks shall not be shortened, nor the nailing space decreased. This is done to prevent earth from heaping up in front of the brace. A light platform is needed to make the use of the ditcher safe.

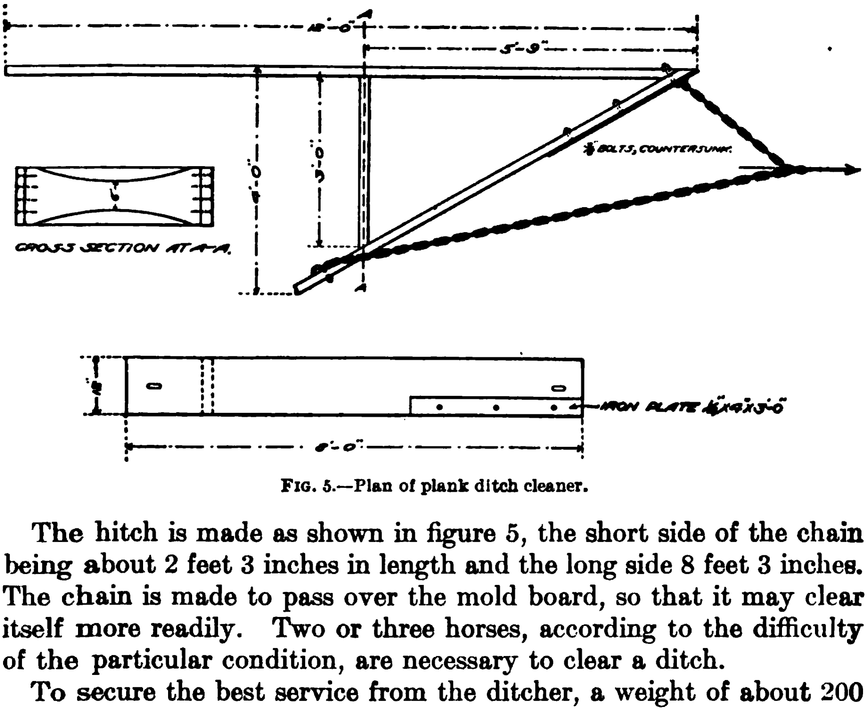

FIG. 5.—Plan of plank ditch cleaner.

The hitch is made as shown in figure 5, the short side of the chain being about 2 feet 3 inches in length and the long side 8 feet 3 inches. The chain is made to pass over the mold board, so that it may clear itself more readily. Two or three horses, according to the difficulty of the particular condition, are necessary to clear a ditch.

To secure the best service from the ditcher, a weight of about 200 pounds should be placed over the front end. The essential thing to be gained is to have the ditcher maintain a smooth, even surface on the bottom of the ditch. There is then no obstruction to the flow of water. This requires that soft, muddy holes be passed over lightly and hard, high places be reduced. This result is obtained if the driver shifts his weight forward or backward as a high point or a mudhole is approached. If the driver shifts his weight forward, the point of the ditcher is driven into the ground. If he moves back, the pres-

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FARMERS' BULLETIN 322.

MILO AS A DRY-LAND GRAIN CROP.

BY

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1908.

LETTER OF TRANSMITTAL

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 3, 190

Sir: In connection with the regular work of the Office of Grain Investigations conducted for the past five years on experimental far and at other points in the Southwest, much success has been attain in the improvement of grain sorghums, particularly in the productio of dwarf strains of milo characterized by good seed production a erect heads. It appears that much of this information is sufficient definite and of such a practical nature as to make it of immedia benefit to the many farmers who are now settling in the semiar plains, particularly as milo is one of the most satisfactory dry-la crops that can be employed. This matter has been brought together the accompanying manuscript by Mr. Carleton R. Ball, Agronomis in Charge of Grain Sorghum Investigations, and Mr. Arthur H Leidigh, Superintendent of the Amarillo Experimental Farm, Am-rillo, Tex., and I would recommend its publication as a Farme Bulletin.

Respectfully,

B. T. Galloway,
Chief of Bure

Hon. James Wilson,
Secretary of Agriculture.

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MILO AS A DRY-LAND GRAIN CROP.

WHAT MILO IS.

RELATIONSHIPS AND CLASSIFICATION.

The sorghums[a] grown in this country may be separated into four groups: (1) Broom corns; (2) sorgos, or sweet sorghums; (3) kafirs, and (4) durras. The broom corns are grown only for their brush, the sorgos for forage and sirup, the kafirs for grain and forage, and the durras almost exclusively for grain.

Milo (fig. 1) belongs to the durra group, which contains also white durra ("Jerusalem corn," "rice corn," "white Egyptian corn") and brown durra ("brown Egyptian corn"). The durras are characterized by dry and rather pithy stems and large, oval or egg-shaped, mostly pendent ("goose-necked") heads. The number of leaves on

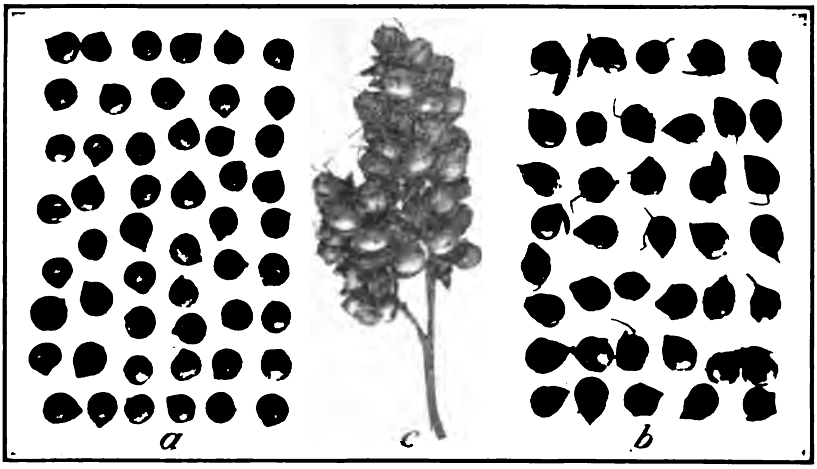

FIG. 1.—Seeds of milo. *a*, cleaned seed; *b*, seed in hulls; *c*, small branch of head, showing awns on spikelets. (Natural size.)

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[a] For further information as to the sorghums, the reader is referred to the following Farmers' Bulletins, which will be sent free upon receipt of a request addressed to the Secretary of Agriculture: No. 135, "Sorghum Sirup Manufacture"; No. 174, "Broom Corn"; No. 246, "Saccharine Sorghums for Forage"; No. 288, "The Nonsaccharine Sorghums."

each stalk is only 8 to 10 on the average. This scanty foliage and the pithy stems make them of little value for forage compared with kafirs and sorgos. The seeds of the durras are larger than those of the kafirs and sorgos, are nearly circular in outline, and are usually somewhat flattened.

The chief varieties of the durra group may be separated as follows:

Seeds white; hulls pale; flower awned	White durra.
Seeds reddish brown; hulls pale; flower not awned	Brown durra.
Seeds pale yellowish; hulls dark; flower awned (fig. 1)	Milo.

ORIGIN AND INTRODUCTION.

Milo was introduced into the United States between 1880 and 1885 and was first grown in South Carolina or Georgia. It came probably from Africa, but this is not certainly known. No sorghum brought since from Africa has been exactly like milo, though one found in Egypt and called there durra safra, or yellow durra, is quite similar to it.

Milo was first widely advertised and sold by the M. W. Johnson Seed Company, of Atlanta, Ga., in the spring of 1887. It soon became distributed over the South and as far west as Texas. In western Texas, and especially in the Panhandle region, it has become popular and widely grown because of its drought resistance and comparative earliness.

COMMON NAMES.

Milo was first known as "Yellow Millo Maize." The adjective "yellow" was applied because of the yellowish color of the seeds and because a white-seeded sorghum, related to the kafirs, was then being sold and grown as "White Millo Maize." Many other names have since been applied to milo. Among them are Branching doura. Dwarf milo, Dwarf milo maize, Dwarf yellow milo, Millo, Millo maize, Milo maize, Red Egyptian corn, Rural branching sorghum. Yellow branching dhoura, Yellow branching millo maize, Yellow branching sorghum, Yellow millo maize, Yellow milo, and Yellow milo maize. Several of these names are occasionally applied to brown durra also. Dwarf milo, Yellow milo, and Milo "maize" are the names most commonly used for milo.

The name "milo" is adopted and recommended because it is short, distinctive, and appropriate. The word "maize" should never be used for milo, as it confuses this crop with corn.

VARIETIES.

There is only one well-marked variety of milo yet offered for sale by seedsmen. It is usually sold as "yellow milo" or "yellow milo maize." What is commonly sold as "dwarf milo" is the ordinary milo grown on the dry and elevated plains of western Texas, Oklahoma, and Kansas, where it reaches a height of 4½ to 5½ feet. It is thus dwarfed because of the conditions under which it is grown. When its seed is carried to lower and more humid districts the crop grows to a height of from 7 to 10 feet, according to the conditions of soil and moisture. On the other hand, seed from this lowland crop if taken to the high plains will produce only the dwarfed crop 4½ to 6 feet tall. The ordinary "yellow" milo and the "dwarf" milo of commerce represent, therefore, one and the same thing, which is discussed in this bulletin simply as milo.

The only true "dwarf" milo known to the writers was secured a few years ago from Judge J. F. Bradley, of Memphis, Tex., who states that the original seed was brought from Oklahoma. So far as known, this dwarf strain (see fig. 4) is not yet handled by seedsmen. It is described later in the paragraph on the characters of improved milo. The so-called "giant milo" occasionally met with in the Plains region consists of hybrids of milo with other sorghum varieties, usually kafirs or sorgos.

CHARACTERS OF ORDINARY MILO.

When first introduced milo (fig. 2) was suitable for use only as a general forage crop. Owing to its small and scanty leaves and pithy stems it was inferior to kafirs and sorgos for forage purposes. On the western plains it began to be developed as a combined grain and forage crop. Like all sorghums it was strongly drought resistant. Compared with some other grain varieties of sorghum it was only fairly early and productive, but it possessed good seed-holding power, which white durra ("Jerusalem corn") and brown durra sadly lacked. From the standpoint of grain production it had, besides these desirable characters, several very objectionable habits. These were (1) the abundant stooling, (2) the free branching, (3) the size and height of the stem, and (4) the pendent, or "goosenecked," heads. (See fig. 6.)

Why are these four habits objectionable in a grain variety?

Stooling (1) and branching (2) prevent uniformity of height and of ripening. In sorghums the suckers comprising the stool from a single main stalk do not all develop at one time. In the same way the branches appear successively rather than all at once, beginning at the second node from the top and progressing downward. These suckers and branches produce heads which ripen at different dates, but none of them as early as the main heads. These branches and suckers are also of different heights, some higher and some lower than the main stalks. Uniform height and ripening are very necessary in a grain crop. The habit of suckering and branching mu therefore be checked by selection.

The size and height of the stems (3) make hand cutting diffic and heading by machinery almost impossible.

The pendent heads (4), hanging downward (see fig. 2) from th apex of the recurved peduncle or stem, are an especial nuisan Their position not only prevents the use of headers in harvesting th seed crop but makes it very difficult to handle the heads satisfacto

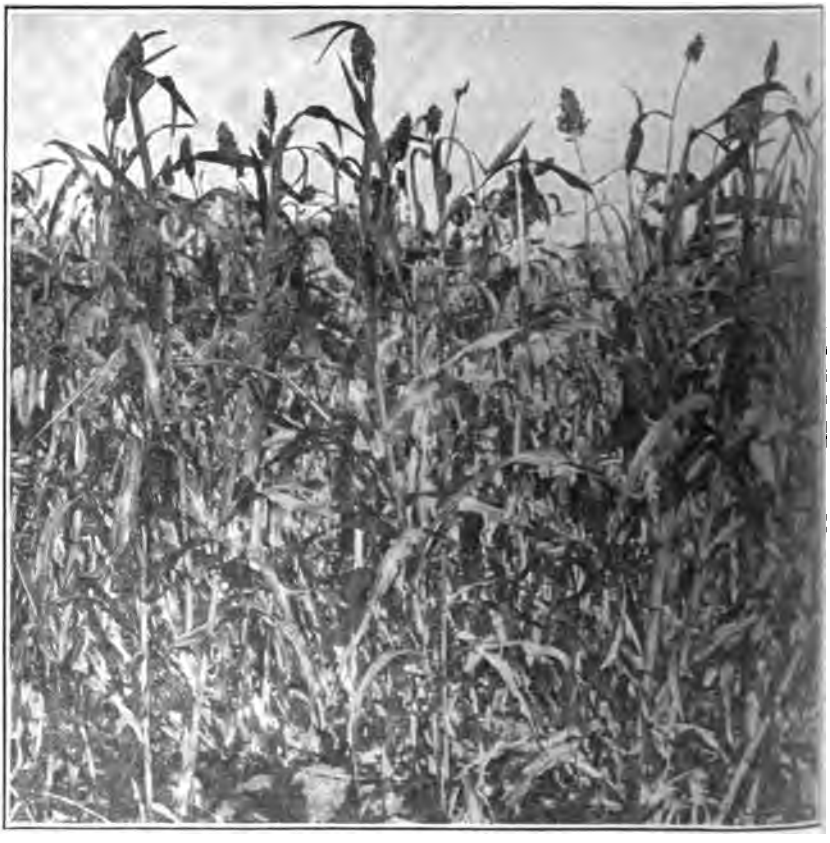

FIG. 2.—Field of the ordinary unselected milo, from 6 to 7½ feet tall, with st branched stems and pendent heads.

in any way. They are in an awkward and dangerous position to c by hand. The curved stem is likewise objectionable. It preve the stalks from lying parallel when cut. It makes the tops of bund wider than the bottoms, thus forming shocks that can neither wi stand winds nor turn water. The crook of the stem is always int locking with adjacent stems, so that they can scarcely be separat in field or shock.

Such were the characters of the original milo and such is in large measure the unimproved crop to-day.

CHARACTERS OF IMPROVED MILO.

In the past four or five years the development of milo as a grain crop has been progressing rapidly along the lines just shown to be desirable. The carefully selected milo (fig. 3) of to-day is a great improvement over the common, unselected crop. Ordinary milo has been reduced by selection to a uniform height of 4 to 4½ feet in the Plains regions lying at an elevation of 3,000 to 4,000 feet above sea level, or at an equivalent latitude. Through selection and thicker seeding the heads have been changed from mostly pendent to mostly erect. All heads not leaning over more than 30 degrees from the perpendicular (see fig. 7) are classed as erect, since for all practical purposes they are erect. From 75 to 90 per cent have been brought to this position in different strains. A large part of the remaining 10 to 25 per cent are merely inclined, i. e., bent over more than 30 degrees and less than 90 degrees, or the horizontal position. These inclined heads would be readily gathered by a header. Only a very small percentage of the heads are pendent, i. e., declined below the horizontal line.

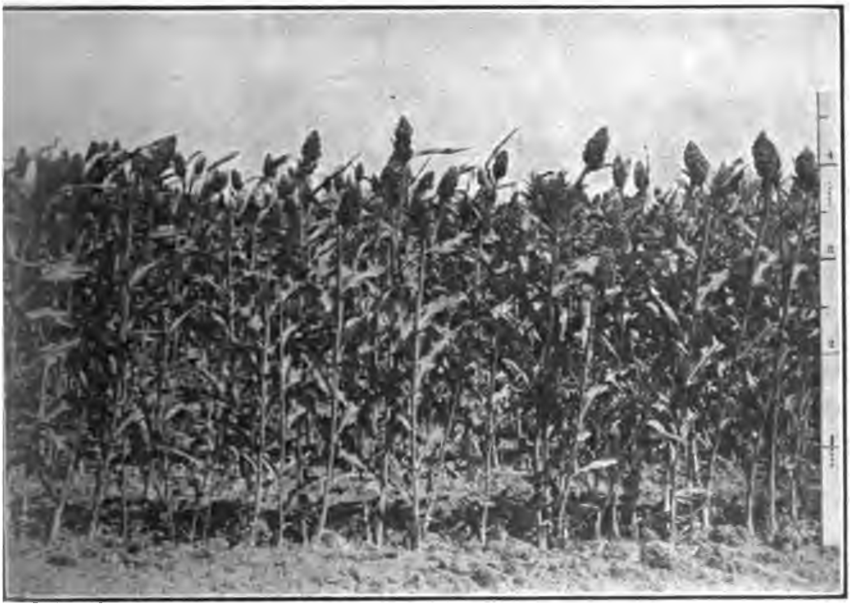

Fig. 3.—Field of milo as improved by selection, from 4 to 4½ feet tall, slender, without branches, heads erect.

By the combined influences of selection and thicker seeding, branching has been almost entirely prevented, and stooling, or the production of suckers, has been greatly checked. About one-fourth to on half the plants produce no suckers at all, and most of the remaind produce only one sucker on each plant. Earliness has been increa until these strains ripen in ninety to one hundred or one hundred a ten days under the conditions of altitude and climate found in wes ern Texas and adjacent territory. The grain yields of the crop hav been maintained and increased during all these changes in habit.

A true dwarf strain (fig. 4), growing only 3 to 3½ feet in heigh under the same conditions as the ordinary taller strain, has been im proved in the same way as the ordinary milo, though the changes ar not yet quite as firmly fixed.

All the work of selection and improvement here outlined has be done by the writers, under the direction of the Office of Grain Inve tigations. Most of it has been carried on at the experimental far maintained by the office mentioned, formerly at Channing, Tex., an now at Amarillo, Tex. These improved strains are not yet genera on the market, but are gradually finding their way to the seedsm and probably will soon be obtainable by everyone interested.

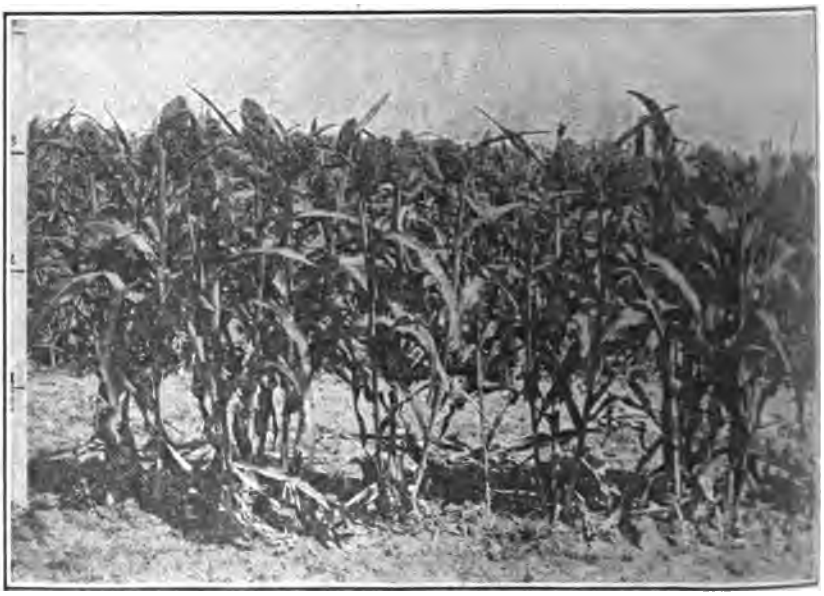

FIG. 4.—Field of the true dwarf form of milo, from 3 to 3½ feet high.

WHERE TO GROW MILO.

Milo is at present the most successful summer grain crop for th southern half of the Plains region. It is an earlier and mor drought-resistant crop than corn and makes a satisfactory feedin substitute. The highest average yields of corn under the same conditions have been ten bushels to the acre less than those of milo. The yields of blackhull kafir have been five bushels less to the acre.

Milo is now a staple crop in a large part of western Texas and in the adjacent portions of New Mexico, Colorado, Kansas, and Oklahoma. This section lies at elevations of 1,500 to 4,000 feet above sea level and has a varying annual rainfall of 17 to 25 inches. Milo is well adapted to the whole southern half of the Plains region lying below an elevation of about 4,500 feet.

Milo can be grown successfully on the lower plains of eastern Oklahoma, eastern Kansas, and southern Nebraska, where kafir varieties are now the leading grain sorghums. In this eastern section of the plains corn is ordinarily a profitable crop, and the acreage of milo will depend on seasonable variations. In dry years milo should be largely grown there, but in wet years it will be replaced by corn to a considerable extent.

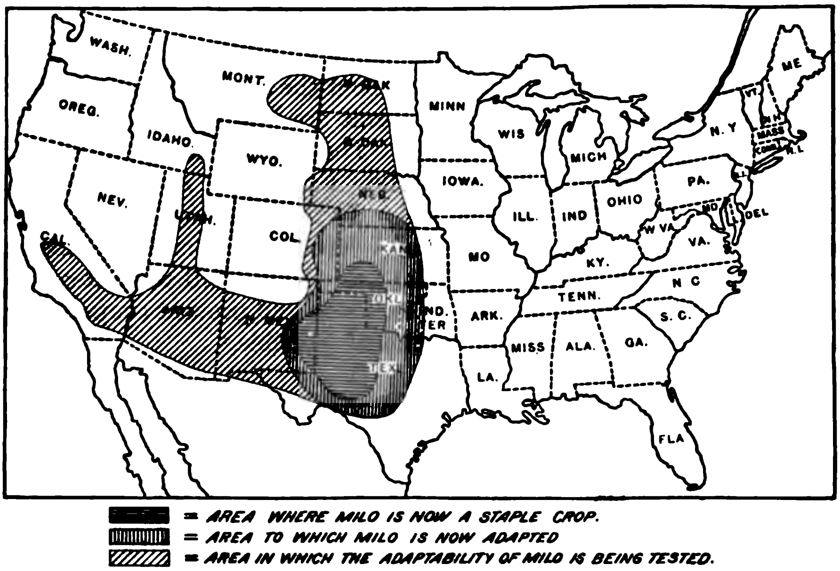

FIG. 5.—Map of the United States, showing where milo is or may be grown.

It seems very probable that the limits of successful production of milo can be rapidly extended northward and westward from the present area. The accompanying map (fig. 5) shows (1) the area where milo is now a staple crop, (2) the area to which milo is now well adapted, and (3) the area in which milo is being thoroughly tested and in much of which it will probably be grown successfully.

In 1907 milo was ripened at several points in eastern Colorado at elevations of 5,500 to 6,000 feet. It was fully matured at the agricultural experiment substation at North Platte, in western Nebraska.

At the experiment substation at Highmore, in central South Dakota. at an elevation of 2,000 feet, in latitude 44° north, the earliest milo was just ripe when frost occurred, on September 26, 1907.

Early strains of milo will be thoroughly tested in 1908 over all the northern Plains region and throughout the Great Basin or intermountain area as well. Farmers ripening milo outside the limits of present production should very carefully select their seed from hardy and early-maturing plants, thus founding a strain suited to their conditions.

Milo is not adapted to humid regions and should not be grown in them.

HOW TO GROW MILO.

SOILS.

The soil requirements for milo are about the same as those for corn. Well-worked sandy loams or clay loams are best. Light sands and heavy clays are much less desirable. The roots penetrate to depths of 3 to 4 feet in ordinary friable soils. Fair yields result on rather poor lands; better yields in good soils. In the semiarid country much depends, however, on the way the soil is handled to conserve moisture. Early and deep plowing to catch and hold the rainfall when it comes, with surface cultivation to keep down weeds and prevent evaporation, are the two principal lines of treatment possible.[a]

PREPARING THE SEED BED.

Fall plowing is preferable to spring plowing where it can be done, because it increases the water-absorbing power of the soil. Deep plowing is better than shallow plowing for the same reason and because it encourages deeper rooting. Harrowing should be thorough before sowing to mellow the soil for the seed bed and to destroy any weeds that may have started. Increased labor in preparing a field before sowing is almost always well repaid by an increased yield of the crop.

On sandy soils or other soils which blow about in windy weather, fall disking and medium-deep spring plowing may be required. When the lister is used, disking in the fall or early spring is advised, or double listing may be practiced. Milo usually makes a fair crop on fresh sod and in the semiarid regions is thought to be the best crop for spring-broken sod land. The seed is dropped in every third or fourth furrow while breaking and covered by the next sod turned or is planted with a shoe drill. The crop thus sown can not usually be cultivated.

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[a] For a full discussion of this subject the reader is referred to Farmers' Bulletin No. 266, by George H. Failyer, entitled "Management of Soils to Conserve Moisture, with Special Reference to Semiarid Conditions." This bulletin may be obtained by application to the Secretary of Agriculture, Washington, D. C., or to any Senator or Representative in Congress.

PLANTING THE SEED.

It should be remembered that the following directions for planting, especially those concerning the rate and the manner of sowing, are for growing milo as a grain crop. Those who are familiar with handling this and other sorghums as forage crops should note the difference required in the rate of seeding and in other practices.

Time of Planting.

The time to plant varies, of course, with the latitude and altitude. In general, milo should be sown about two to four weeks later than the average date for planting corn. The average date will therefore vary from about April 15 in southern Texas and the lower Southwest to about May 25 on the higher plains of northwest Texas, and to about June 1 to 15 in Nebraska and South Dakota. Because of its earlier maturity, milo can be planted later than the varieties of kafir wherever they are safe crops. Milo should not be sown until all danger of spring frost is past and the soil has become warm.

Methods of Planting.

Milo may be either listed or surface planted, as the experience in any particular locality has shown to be the best for crops of this class. Listing is a common practice in much of the Plains region where milo is now, or is likely to become, a staple crop. Certain advantages are secured from listing. The young plants are protected from the strong winds of spring and from the cutting action of sand carried by such winds, which sometimes cuts the stems of surface-grown crops entirely off. The root systems of listed crops are also said to lie deeper, because of the deeper sowing, but this fact is doubtful, owing to the later growth of surface roots. On the other hand, listing tends to make the crop ripen later because the young plants at the bottom of the furrow grow more slowly than those planted at the surface. In wet seasons the lister furrow fills with water and the young crop may be either washed out or covered up with sand or mud.

Surface sowing is the rule in a large part of the milo country and will probably increase in importance as a method of sowing even in sections where listing is now generally practiced, since better methods of conserving soil moisture are becoming understood.

Whether listed or surface sown the most common way of sowing milo is by means of special sorghum plates used in the corn planter or lister planter.

Rate of Planting.

For the highest yields of grain from 4 to 6 pounds of seed to th acre is sufficient if the seed is of good quality. Milo is usually sow in rows 3½ feet apart; sometimes only 3 feet apart. The quantity seed used will vary somewhat with differences in soil and clima Sections with rich soils and more abundant moisture can sow m more thickly in the row than sections having thin sandy soils a lighter rainfall. Several years' tests on the experimental farm of th Office of Grain Investigations, at Amarillo, in the northern part the Texas Panhandle, show that one plant to every six inches of ro gives the highest grain yields under the average conditions obtain there. The soil on this farm is a good clay loam, the elevation 3,600 feet above sea level, and the average annual rainfall about inches. Four pounds of seed to the acre produce under these fi conditions plants averaging 6 to 8 inches apart—the desired sta Thicker stands than this have generally been recommended for gra production but are not desirable under Panhandle conditions.

These figures are intended to be suggestive rather than final. A series of experiments covering three or four different rates of seeding must be carried on for several years at different points in the mil belt before the question of how much to sow to the acre can be ful settled. The best rate may prove to be different for each differen set of conditions of soil, moisture, and length of growing season. I will also be dependent to a considerable extent on the cultivati given. Until these facts are more fully known, each farmer shou test for himself two or three different rates of seeding. Four pound six pounds, and eight pounds of seed to the acre are suggested f such trials.

Where the plate on the planter can be set to run at different spee only one plate will be required for planting seed at different rates t the acre. The proper speed to use for each desired rate can be ascertained by testing the planter on a floor or smooth, hard piece of ground. The distance at which the seeds are dropped can then be very readily observed and the proper distance secured. Where th speed of the plate can not be changed, several plates with differen numbers of holes will be necessary to secure different rates of planting. Each hole should be large enough to drop two small seeds once, but not two medium-sized or large ones. The holes should be countersunk well on the under side of the plate. The number of holes required in the plates in order to drop seeds 3, or 6, or inches apart, respectively, can readily be figured out for each kin of planter, the holes then drilled by the farmer or a blacksmit and the results tested as described above.

In general, thick sowing produces small stalks and small, erect heads, but many more heads on an acre. Thin seeding makes larger stalks and larger heads, but fewer of them. Thin sowing also produces a larger number of the objectionable pendent heads.

CULTIVATING THE CROP.

The cultivation of milo is much like that of corn. Milo, like all sorghums, grows slowly at first and may become choked by weeds on foul land unless care is taken. The harrow or the weeder should be freely used in such cases, running in the same direction as the rows. This applies both to listed and to surface-sown crops. When the plants are sufficiently large, any ordinary style of cultivator may be used. The various special tools for cultivating young listed crops are well adapted for use with milo. The earliest cultivation may be deep if desired, but after the root system has filled the space between the rows, cultivation should not be more than 2½ to 4 inches deep. Such shallow tillage does not injure the roots and keeps the surface in fine tilth, thus conserving moisture by preventing evaporation.

SELECTING AND SAVING SEED.

In the case of a new crop, like milo, it is very desirable that each farmer select carefully his own seed. This is especially true of the farmer who is outside the present milo region. If he is at a greater elevation, or at a more northern latitude, or in a more arid district than that of the principal milo belt, good home-grown seed will be best for his sowing. Selected seed will also be much better than ordinary bulk seed, even from his own fields.

As previously noted, the most important points for which milo is being selected are (1) earliness, (2) drought resistance, (3) productiveness, (4) uniform height and ripening, (5) freedom from branches and suckers, and (6) erect heads. (Figs. 6 and 7.)

Selections for any or all of these points must be made in the field instead of after the crop is harvested. Except for earliness and uniform ripening, the selecting may be done any time before harvest. Wherever earliness is an important point, the selecting must be done when the earliest heads are maturing, since later, when all have ripened, the early heads can no longer be distinguished from later ripening ones.

Selections should, if possible, be made in a part of the field where the stand is good and other conditions are the average. There is always a temptation to select where the stand is thin because of the fine large heads produced in such spots. In selecting for productiveness, or high yields, stalks should be chosen having the largest and heaviest heads where the stand is fairly thick. Erect, early-ripening heads on stalks of equal and average height, free from suckers and branches, should be selected and plainly marked in the field. Marking may be done by means of a pasteboard tag, a bit of white cloth. or a piece of white paper securely tied to the stalk just below the head. If tied so that it can flutter in the breeze, so much the better. as it will be easier to find the heads when they are to be gathered. The heads should be left on the stalks in the field until fully ripe. when they may be gathered by hand and hung up to a rafter or on the wall of the granary or toolhouse to dry. They may be laid on a shelf in a well-ventilated room if the layer of heads is not made too thick, but should not be hung in a stable, as the moisture is likely to injure the seed. They may be allowed to hang all winter and be thrashed out in early spring. Before planting time the seed should be tested for germination.[a]

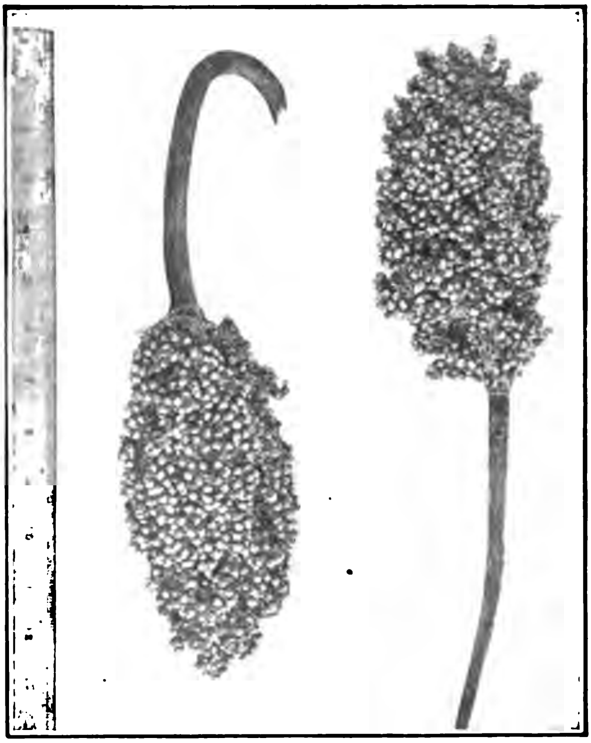

FIG. 6.—Milo heads; one pendent, one erect.

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[a] For a simple method of testing the germination of seeds the reader is referred to Farmers' Bulletin No. 111 (p. 21), which may be secured on application to any Member or Delegate in Congress or to the Secretary of Agriculture.

Any farmer who feels that he can not spare the time to select enough seed for sowing his entire field of milo for the succeeding season can at least select enough to sow an acre or more to be used as a seed plat. Forty or fifty heads will be quite sufficient for an acre. Good results may often be obtained by placing the work of selection in the charge of a bright boy. Help him to get in mind the desirable type of plant and interest him in improving the crop. Some premium might be given him if his selected seed plat outyields the unselected field.

HARVESTING THE CROP.

Where sown as suggested milo is usually harvested with a corn binder and cured in the shock (fig. 8). In ordinary milo the recurved stems and pendent heads make the bundles so large at the top that shocks made from them are not firm, but are easily blown over by wind and wet by rain. Our improved strains, with heads mostly erect, are not open to these objections. When milo is bound with either the corn binder or grain binder, the heads may be cut from the bundles with a broadax or a heavy knife hung at the tip. The crop may also be thrashed without heading, or it may be fed in the bundle without thrashing.

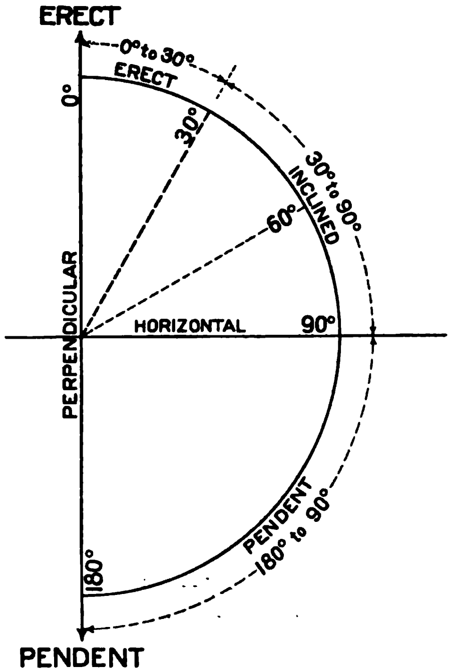

FIG. 7.—Diagram showing named positions of heads of milo.

Heading the crop in the field is naturally the most desirable method of harvesting, since it saves handling the stover and makes thrashing easier and more rapid. Ordinary milo, with pendent heads, can not be successfully harvested with any kind of header. The improved strains are adapted to harvesting with the row header, the grain header, or with either binder. A suitable type of row header is very much needed for harvesting all forms of grain sorghums.

Some machines of this kind are in use to a limited extent for heading kafir varieties. These machines (fig. 9) are built for attachment to the wagon box. As at present made, they can not be adjusted to a large enough variation in the height of the crop. They also harvest but a single row at a time. It is likely that in regions where wheat headers are in use they will be utilized to head the milo also. This can readily be done where the crop is not more than 4 feet in height and the heads are erect.

Heretofore it has been a common custom to cut the heads from the stalks in the field by hand, especially on small areas. Owing to the pendent position of the heads in the unimproved crop, this is a slow, difficult, and often dangerous method. It would hardly be profitable on a large scale with either crop.

Milo may be harvested by any method as soon as ripe. It is the common custom in northwest Texas to allow milo to stand for some weeks after it is ripe before cutting it. Where the crop is to be thrashed, this matters little, but where the milo is to be fed in the bundle it is a wasteful practice. The leaves, always scanty, are dried out, break off in the wind, and are lost. The stems become hard, woody, and unpalatable. The feeding value of such stover is much lowered. It is not at all necessary to so treat the crop. The stems of milo are naturally dry and pithy, and so ripen nearly as early as the heads, which is not true in the stouter and more juicy kafirs. When it is to be cured in the shock and fed in the bundle it may be cut as soon as the seed is in the hard dough stage.

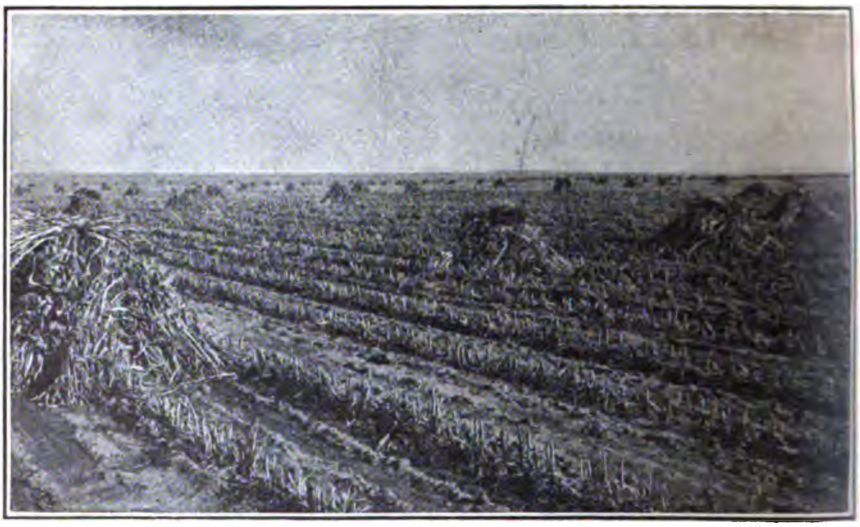

FIG. 8.—Field of milo in shock, Channing, Tex.

THRASHING THE SEED.

Thrashing is readily done in an ordinary grain separator. To avoid cracking a considerable proportion of the seed, the concaves ay be replaced with boards or part of the concave and cylinder eth removed. The speed of the cylinder should also be reduced to bout 600 revolutions a minute. Where the thrashed seed is intended r feeding to stock, there is no objection if much of it has been racked in thrashing. In fact, milo is usually cracked or ground efore being fed to stock, because otherwise much of it passes through e cattle without being digested. But where intended for use as ed grain it is, of course, worthless if cracked. Where it is desired thrash shocked milo, the heads may be cut from the bundles as ggested or the bundle may be held in the cylinder until the grain

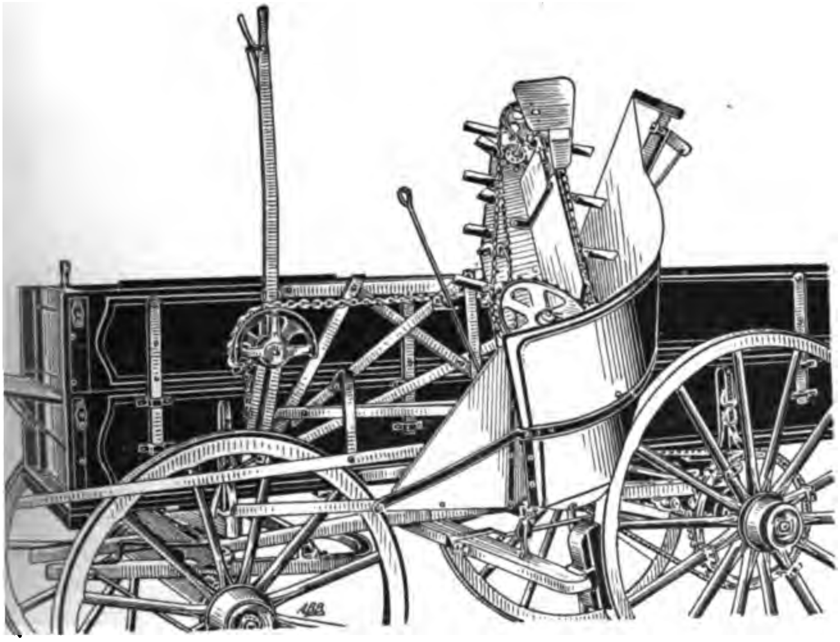

FIG. 9.—A form of row header used for kafir varieties.

all removed from the heads and then thrown to one side. It is arcely profitable to thrash the whole bundle, though this is com- only done.

YIELDS OF GRAIN.

The yields obtained at the Amarillo and other experimental farms f the Office of Grain Investigations during the past five years have veraged almost exactly 40 bushels of milo to the acre. The highest as been 46 bushels. Yields of 30 to 55 bushels are reported by armers. The seeds when of good quality weigh fully 60 pounds o the bushel. The limits of yield have probably not been reached nd the average is likely to increase as the crop becomes more care- ully selected and more intelligently handled.

HOW TO USE MILO.

FEEDING ON THE FARM.

The principal use of milo on the farm will be as a feeding grain,[a] similar to corn. Chemical analyses show that the seeds of corn and milo are nearly identical in composition. Whether the feeding values are as nearly equal is not certainly known. No accurate experiments have been made to determine this fact. Experiments made with the grain of kafir varieties prove them to be a little less valuable than corn for feeding purposes. Milo is equal to or somewhat better than the kafirs as a feeding grain. Unlike kafirs, milo has a beneficial laxative effect on the bowels.

More and more milo is being fed as a thrashed grain. To prevent waste by imperfect digestion, it is best to crack or grind milo before feeding. Where hogs follow cattle, the waste in feeding whole grain is reduced, but the cattle will do better on the cracked than on the whole grain. The grain, like corn, gives the best results when fed with some other feed containing more protein, such as alfalfa, cotton seed, or cowpea hay.

Where milo is headed in the field or from the shock, the heads may be fed whole, or they may be ground and fed, or they may be thrashed and the grain fed. The whole heads are readily ground in any large feed mill, though thrashing first and then grinding the seed is said to require no more power.

A considerable amount of milo is fed in the bundle, especially localities where little grain is grown and separators are not common. This is a fairly satisfactory way of handling the crop, provided the stand is fairly thick and it is cut as soon as ripe, before the stalks become bare and woody. When feeding milo in the bundle, care should be taken that no more is placed in the feed racks than is eaten each day. Stock will not thrive where their ration becomes moldy much mussed over in the racks. Many cases of "blind staggers" other sickness have been directly traced to feeding such moldy food stuffs.

SELLING THE GRAIN.

There is now a growing market for milo grain. Apparently, increasing quantities are being used in poultry foods and in the ome is sold on local markets for seed or for feeding purposes, but most of it is fed on the farms where grown.

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[a] The only feeding test with milo of which the writers have knowledge reported in a circular issued by the Texas Agricultural Experiment Station entitled "Panhandle Feeds for Beef Production." The experiment was carried out at the XIT Ranch, Channing, Tex., by J. J. Edgerton.

PRUSSIC ACID POISONING.

All kinds of sorghums, including Johnson grass, sometimes become oisonous through the formation of deadly prussic acid in their eaves, especially when their growth is checked by any cause, such as rought or frost. They are dangerous only in the green state and re harmless when cut and fully cured. The grain is never poisonous. The writers have heard of no cases of such poisoning from green milo, but this may be because, unlike sorgos and kafirs, it is almost never pastured.

INSECT ENEMIES AND FUNGOUS DISEASES.

INSECTS.

Milo has few serious insect pests. Chinch bugs are occasionally roublesome to this as to all other sorghums. Aphides, or plant lice, sometimes occur in great abundance on the leaves of young milo and other sorghums. When very abundant they tend to stunt the plants by sucking the juices from the leaves. The fall army worm[a] (*Laphygma frugiperda* S. & A.) sometimes does considerable damage to milo and other sorghums. The larva, or worm, of this moth is arge, somewhat resembling the corn or cotton boll worm in size and color. The adult deposits its eggs in the unfolding upper leaves before they unroll. The injury done by gnawing back and forth through the tightly coiled leaf appears as a series of parallel rows of round holes in the expanded leaf. Such leaves are frequently lost by breaking off on a line of these holes. The nearly full-grown worm, especially of the later broods, is particularly fond of tunneling in the stem, 3 to 6 inches below the head, being protected by the sheath of the upper leaf. Frequently the stem is so weakened that it breaks in the wind and the young head droops over and dies, turning conspicuously paler. The worms occasionally enter the head itself, where they do more damage by fouling it with their excrement than by the quantity of grain actually eaten.

In southern and eastern Texas the larva of the sorghum midge (*Diplosis sorghicola* Coq.) prevents seed production by absorbing the juices from the young ovary so that the grain never develops. This is the trouble often called " blast " by farmers.

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[a] A detailed account of the fall army worm is given in Bulletin No. 29, new series, of the Bureau of Entomology.

FUNGI.

Milo is very free from fungi. It is especially noteworthy tha has never been known to be attacked by the kernel smut of sorgh so destructive to most varieties. The head smut of sorghum also never been found on milo.

SUMMARY.

Milo is one of the durra group of sorghums, closely related white durra (“ Jerusalem corn ”) and to brown durra. It is prob bly of African, perhaps Egyptian, origin and was introduced in the United States between 1880 and 1886.

Milo is recommended as a short and suitable name for this cr It is commonly known as dwarf milo, yellow milo, and milo “ maiz The last name confuses it with corn.

There is only one variety handled by the seed trade. What is as “ dwarf ” milo is ordinary milo grown on the drier plains, whe for lack of moisture it is low in stature. There is a true dwarf mi but it is not yet generally sold on the market.

Ordinary milo stools freely at the base and branches freely above tall and rather stout, and is not uniform in height or in time or rip ing. The heads are mostly pendent. As a crop it is difficult handle rapidly and satisfactorily.

Improved or selected milo has to a large extent been prevent from suckering and branching, is low and rather slender, is unifo in height and ripening, and has its heads mostly erect. It may handled easily by machinery and is fitted for harvesting with head

Milo is widely grown in western Texas and adjacent parts of N Mexico, Oklahoma, and Kansas. It is well suited to the entire sout ern half of the Plains region below 4,500 feet elevation. It can pr ably be profitably grown as far north as South Dakota and westwa in Colorado and New Mexico to elevations of about 6,000 feet; lik wise in the Great Basin region.

The soil requirements of milo are much the same as those of co The land should preferably be fall plowed and well prepared spring to hold moisture and destroy weeds.

In general, milo should be sown about three weeks later than co and after all danger from frost is past. Milo may be listed or sow at the surface as local conditions require. The seed is sown by me of special sorghum plates used in either the corn planter or the li planter.

The best rate of planting for highest grain yields lies probab between 4 and 6 pounds to the acre, depending somewhat on th character of the soil, the average rainfall, the length of the sea and the cultivation given. Four pounds to the acre has given the best results in the Texas Panhandle. The rows should be about 3½ feet apart and the stalks 6 to 8 inches apart in the row.

The cultivation of milo is essentially the same as that for corn.

Farmers should carefully select their own seed of milo, especially where it is not yet a staple crop. Selection is usually made for (1) earliness, (2) drought resistance, (3) higher yields, (4) uniformity, (5) freedom from suckers and branches, and (6) erect heads. The yield and value of the crop can be greatly increased by such means. Select enough for a small seed plat if time lacks for more extensive work. Interest the farm boys in this work.

Harvesting is usually done with a corn binder or by cutting the heads by hand. Ordinary milo can not be headed by machinery because of the pendent heads. Our improved milo with erect heads may be cut with a grain header or with a row header. A good adjustable kind of row header is much needed.

Thrashing is done with a grain separator. Slowing the cylinder and removing the concaves or part of the concave and cylinder teeth will prevent cracking the seed.

Yields vary from 25 to 55 bushels of seed to the acre. The yields in the Panhandle of Texas average about 40 bushels to the acre. As tillage methods and the crop itself are improved the yields should be increased.

Milo is used mostly as a feeding grain on the farms. It may be fed as thrashed grain, in the head or in the bundle. The grain is preferably cracked or ground before feeding, except for poultry. The heads may also be ground. Milo is entering more and more into the production of chops and poultry foods.

Milo, like other sorghums, may become poisonous in the green state, especially when checked or stunted in growth.

The principal insect enemies are the chinch bug, aphides or plant lice, fall army worm, and sorghum midge. The last may totally prevent seed production in the Gulf region.

Milo is entirely free from the kernel smut and the head smut of sorghum.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 323.

CLOVER FARMING ON THE SANDY JACK-PINE LANDS OF THE NORTH.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 4, 1908.

Sir: I have the honor to transmit herewith a paper entitled "Clover Farming on the Sandy Jack-Pine Lands of the North," by Mr. C. Beaman Smith, Assistant Agriculturist, prepared under the direction of the Agriculturist in Charge of Farm Management Investigations of this Bureau.

Large tracts of sandy pine lands occur in several Northern States, particularly in Michigan, Wisconsin, and Minnesota, which by ordinary methods of farming do not give profitable returns. It has been proved that when special care is taken in handling these lands and special crops are grown a large part of the sandy pine lands can be built up into profitable farms. The growing of clover for seed is one of the special lines that have proved profitable. Exceptionally good yields of high-grade clover seed are now being grown on some of this land, and it is believed that the clover crop, whether for seed, for forage, or for green manuring, is the key to the situation for successful farming on this land.

The manuscript herewith gives a detailed account of the methods of handling the soil and growing clover followed by successful farmers on this land. The data presented apply to many million acres of land in the North now idle because people do not know how to handle them. I therefore recommend that the paper be published as a Farmers' Bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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CLOVER FARMING ON THE SANDY JACK-PINE LANDS OF THE NORTH.

INTRODUCTION.

The sandy jack-pine plains of the States of Michigan, Wisconsin, and Minnesota have long been an agricultural problem. Farmers have generally failed to make a living on them. After building a house and barn, clearing up a patch of ground and cropping it for two or three years, the land has been abandoned. The crops raised were not sufficient to support the farmer or to encourage him to stay longer. More people have left these lands during the last thirty years than are now living on them.

The problem has been whether these lands could ever be farmed profitably or whether they had not best be used for forestry purposes. The recent successes of numerous farmers in growing clover and producing clover seed on these jack-pine lands indicate that a solution has at last been found for profitably farming at least a part of this hitherto rejected land.

This much has been demonstrated: These sandy jack-pine lands can not be farmed in the usual manner with profit. General farming fails. Success will come only from growing specific crops adapted to the soil and climate, and thus far the crop found most profitable is clover for seed. This is a most fortunate circumstance. With clover for a start, either for seed or forage, the land can soon be built up into almost any state of productiveness. It would seem that the key to the successful farming of these lands has been found.

EXTENT AND CHARACTER OF THE JACK-PINE LANDS.

There are perhaps 2,000,000 acres of jack-pine lands in Michigan alone, the bulk of it occurring in the northern central portion of the lower peninsula. In addition there are 8,000,000 or 9,000,000 acres of cut-over pine lands that are generally of a light sandy nature and require specially careful handling to make them productive of farm crops. In Wisconsin there are probably as many as 2,000,000 acres of jack-pine lands, and in Minnesota there are considerable areas of jack-pine and light sandy pine lands. Small areas of land of very similar character are found as far east as Maine.

The typical jack-pine plains are generally rather openly wooded and often park-like in appearance. Jack pine (*Pinus banksiana*) is the common timber, and this is found in all stages of growth from seedlings to trees 35 to 50 feet high. Scattered with the jack pine are scrub oaks, poplars, willows, Juneberry, chokecherry, and other woods of shrubby growth. The small native vegetation consists for the most part of brakes, sweet ferns, huckleberries, wintergreens, and some rather coarse wild grasses. In the autumn golden-rod and wild asters are conspicuous.

The soil is usually a rather light yellow, brown, or gray sandy loam, often of a gravelly nature. Frequently red clay comes to the surface and is sometimes several acres in extent. Generally the subsoil is sandy, often to great depths. Analyses[a] show that the better grades of jack-pine soils are well supplied with the mineral elements necessary for plant growth, but are generally quite deficient in humus and nitrogen. This lack of humus and nitrogen is one of the fundamental reasons for the low productiveness of the jack-pine plains.

As with other lands, the jack-pine soils vary greatly in value for agricultural purposes. Generally that which is most open, sandiest and most thinly covered with native grasses and other vegetation is the least productive. A thick mat of vegetation or dense underbrush containing many briers, willows, Juneberries, poplars, scarlet maples, etc., indicates a more productive quality of soil. The intending purchaser should carefully examine the land before he buys it.

ATTRACTIONS OF THE JACK-PINE LANDS.

The jack-pine land attracts farmers (1) because it is cheap, and (2) because it is easily cleared. It looks as though one could easily make a good farm out of it. Frequently a man can clear 2 or 3 acres a day and get it ready for the plow. The timber being small, most of the stumps can be plowed out the first year and by the second or third year the rest are rotted. This phase appeals to the man who has seen the labor and time taken to clear up a heavily timbered piece of land and get rid of the stumps.

The cheapness of the land, however, is undoubtedly the main reason for settlers occupying it. Much of it has been homesteaded. A great deal of it has had the scattering pine cut off by lumbermen and has reverted to the State or can be bought for back taxes. Thus some the land costs 25 cents to $1.25 an acre. In other cases speculators have bought up the land and by advertisement and otherwise inducing families to settle on it. Speculators are holding it for $5 to $15 an acre.

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[a] Michigan Agricultural Experiment Station Bulletin No. 37.

The sandy pine stump lands present a different problem. The lumber on these lands was largely Norway and white pine. It takes a lifetime or more for the stumps of these trees to rot, while to pull or dynamite them out costs $15 to $25 an acre. The principles of farming are the same on the sandy Norway and white pine stump land, however, as on the jack-pine plains land.

REASONS FOR FAILURES ON THE JACK-PINE LANDS.

The principal reason why farmers have failed on the jack-pine lands is because they attempted to grow grains, roots, and grasses in the same way that they had been accustomed to on the heavier and more productive lands in other sections of the country. The methods of farming observed on heavier, more fertile lands fail here. The plains land is light. It is subject to drought. It is lacking in both humus and nitrogen. The yields by usual farming methods are increasingly disappointing from year to year. On average jack-pine lands handled in the usual manner potatoes will give as a first crop on spring breaking 35 to 60 bushels per acre, wheat 5 to 6 bushels, rye 5 to 8 bushels, oats 10 to 15 bushels and usually light in weight.

Other reasons for failure are deep plowing, burning off the humus, clearing the land at the wrong season of the year, and failure to recognize that the land is light, not adapted to general farming, and needs first of all to be built up with humus and nitrogen before either satisfactory crops of grain, roots, vegetables, or fruit can be grown. Success in farming this land will come from growing special crops like clover seed, potatoes, or truck, not from general farming.

FACTS EVERY SETTLER SHOULD KNOW.

The intending settler on the jack-pine lands needs to know at the utset that this sandy soil needs a little nursing and special care n handling. The land has been repeatedly burned over every few ears for no one knows how many generations; hence, there is little umus or vegetable matter in it. It lacks nitrogen. It is likely to e a little leachy. It is likely to suffer severely in time of drought. t needs protection from the winds. In the beginning it should e plowed shallow. It usually needs rolling to make a firm seed bed, ollowed immediately by dragging to make a dust mulch for retaining the moisture in the soil and to reduce the velocity of the wind ext to the soil surface.

On the other hand, when such sandy land is properly handled it esponds with marvelous quickness to even small quantities of barnard manure, green manure crops, or commercial fertilizers. [illegible] duces splendid crops with barnyard manure alone. The land c be handled whenever the sun shines. It produces a crop ten day three weeks earlier than the heavy clays, and in the case of orch fruits sometimes two to five years sooner. Besides, the quality many crops grown on sandy land is superior.

CLEARING AND BREAKING JACK-PINE LANDS.

The successful handling of the jack-pine plains begins with t clearing of the land. The logs, brush, and stumps must be clear away, but nothing should be burned off that can be plowed und for humus. The great need of the soil is for humus, or veget matter. Rotten logs should be picked to pieces and scattered thi over the ground. All the sweet ferns, huckleberry bushes, brakes, a other small growths should be plowed and not burned off.

Burning over the soil not only depletes it of its humus conte but tends to make a sterile and dead soil of it, since the bacte life which has so beneficial an action in the production of cro is for the most part active only near the surface of the soil. A fierce fire left to run over the land in clearing it will destroy m of these beneficial organisms, leaving the soil inert and unresponsiv like a freshly turned subsoil.

One of the most successful farmers found on the jack-pine pla clears his land and burns the log and brush heaps in the spri or fall, but makes it his general practice not to break the lan until about the middle of July. By this time all the native vege tion, such as the ever-present brakes, sweet ferns, huckleberri wintergreens, wild grasses, etc., has made its principal growth f the season. This mass of weeds, grasses, and shrubby growth then plowed down by the aid of a chain attached to the end of t whiffletree and beam of the plow in the usual manner for plowi under green crops. When the land is broken up in the spring f crops, the roots and underground stems of the native vegetati being full of stored food, start into a vigorous growth, produ stems, leaves, and new plants above ground, which seriously c pete with the planted crops for moisture and a place to grow. Th roots continue to send up stems all summer long, which necessit continuous cultivation to subdue them.

On the other hand, when the land is not broken up until J and early August, the roots have become practically exhauste their stored food supply in producing the growth of stems a leaves above ground. If at this time the ground is plowed and exhausted roots turned up to the hot July sunshine, the plants a more easily and surely killed than at any other time of the year.

After plants have made their full growth above ground for the se son they begin storing food in their roots and stems again for ear spring growth the following season. For this reason fall breaking ikewise is less effective for subduing the native vegetation than summer breaking, because the roots, being full of stored food at the time of the late plowing, start into growth promptly the following spring, being but little injured in that northern climate, where the snow usually covers the ground all winter.

There is still another reason for waiting until midsummer before breaking the land. By that time there is a heavy growth of vegetation. This makes as good a green manure crop to turn under as rye or buckwheat would.

DEPTH TO PLOW JACK-PINE LANDS.

The jack-pine lands are light and thin. What humus they contain is for the most part within 2 or 3 inches of the surface; below that is subsoil. Now, in actual practice the men who are making the greatest success on these lands are plowing but 4 to 5 inches deep. Usually the nearer 4 inches deep the land can be broken up the better the succeeding crop will be. The depth of plowing is only gradually increased as humus and nitrogen are added to the soil. It will probably be found that about 6 inches is as deep as it will ever be found necessary or desirable to plow the lighter lands of the jack-pine plains.

On the more loamy or even clay lands sometimes found on the jack-pine plains the plowing after the land has been enriched with humus can be gradually deepened to 7 or 8 inches; but at the first breaking 4 inches has proved deep enough on any kind of jack-pine land. This point is emphasized here because so many settlers in this region make the serious mistake of burning the land over in the spring to slick it off clean for the plow and then plow it 7 to 8 inches deep. This is a mistake. It puts the thin streak of humus in the surface soil down about 6 inches deep, leaving 3 inches at least of dead subsoil on top of the ground. Seeds started in such a topsoil make a discouraging growth. Clover particularly makes a much better growth when the first breaking is less rather than more than 4 inches deep; and this is the plant above all others that should be encouraged, as it promises to convert these hitherto discouraging lands into profitable farms.

Special attention is called to the desirability of breaking these lands shallow. Successful farming on these lands is absolutely dependent upon the observation of a few apparently insignificant points which on better soils might be overlooked with impunity, but which on these naturally light soils must be observed if productive, prosperous farms are to be built up.

PREPARATION OF THE SEED BED.

After the land has been broken up in July and the natural green manure crop of native vegetation plowed under about 4 inches deep it should be gone over with a roller heavily weighted to pack the loosened soil down firmly. This hastens the rotting of the material turned under. The spring-tooth harrow is commonly employed on the land because with it many of the brakes and other roots which cause so much trouble by continuously springing into life when the land is spring or fall plowed are pulled out and can be gathered up and burned.

That is just what ought not to be done. Leave the trash and roots in the soil. Their decay there means the addition of just so much more humus to it, the thing above all others of which the soil stands most in need. The disk harrow, which cuts the roots up and leaves them in place, is a much more satisfactory implement to use in first working down new breakings. By the use of the disk harrow after the roller, any new growth that comes up between the time the land is broken in July and the time grain is sown in the fall can be easily kept in control. The disk should not run more than about [illegible] inches deep and should be set at only a slight angle. Where the disk is not available, a spike-tooth drag with the teeth slanting slightly backward is the next best implement to use.

If, however, the land is broken in early spring, when the roots and underground stems are filled with stored food, it will be advisable to drag out as many roots and stems as possible in order to reduce their numbers in the field during the growing season.

CLOVER THE KEY TO SUCCESSFUL FARMING ON JACK-PINE LANDS.

The vital fact in farming the sandy jack-pine lands is that clover will grow on it. A second fact is that clover builds up the land faster than any other crop commonly grown there. It supplies at the start both the nitrogen and humus that the soil so badly needs. A third fact is that by growing the crop for seed the enriching effect of the clover on the land can be secured and at the same time a cash crop of greater value than that from any other crop commonly grown on the jack-pine lands obtained. This is a point of paramount importance to the poor settler, who needs every cent he can get off the farm to meet his living expenses. Finally, as a green manure clover is the best crop yet found for the jack-pine plains.

In some sections, particularly in Michigan, very profitable returns have been secured from growing mammoth and common red clover for seed. These lands seem well adapted to clover-seed production. Yields of seed ranging from 2 to 6 bushels to the acre, having a gross ash value of $10 to $50 per acre, have been obtained. For the last ew years the seed yield has averaged a little more than 3 bushels the acre. As the price ranges between about $5 to $9 per bushel, is makes a very profitable crop. The income from clover-seed arming is thus seen to be as great as that from land yielding 20 ushels of wheat or 40 bushels of corn to the acre at average prices. ut whether or not one grows clover for seed or goes into some ther kind of farming, such as the dairy industry, sheep, potatoes. nd the like, it is certain that clover lies at the base of every successul system of farming that has yet been devised for these lands and hould be among the very first crops grown.

KIND OF CLOVER TO GROW.

Of the different kinds of clover the mammoth, bull, or sapling clover ather than the smaller common red clover or the alsike clover has een found most efficient on the jack-pine plains. It seems to grow etter, gives more forage, and yields more seed to the acre than either f the other two varieties. The mammoth clover, of course, produces ut one crop of hay a season, but most of the plains land is so far orth that only one cutting can be safely taken from any kind of lover, while in that section cutting the first crop of common red lover for hay and the second for seed generally results in a very ight and unprofitable crop of seed.

HOW TO SECURE A STAND OF CLOVER.

The first matter for the settler on the jack-pine plains to consider s how to secure a good stand of clover.

SEEDING CLOVER WITHOUT A NURSE CROP.

The surest way to get a stand of clover on jack-pine lands is to seed he crop alone without a nurse crop. Where the land has been broken p in July by plowing down the native vegetation 4 inches deep and olling with a heavy roller, followed by an occasional cultivation ntil fall with a disk harrow or spike-tooth drag, the land will be in he best possible condition for seeding to clover about May 1 of the following spring.

Now, on that light sandy land it has been found best to drill or rag the clover seed in about 2 inches deep. Seeding the clover in pring on top of the land with fall-sown grain, as is the common practice on heavier lands, fails nearly every time it is tried on these light sandy lands. On the other hand, where the seed is put in about 2 inches deep it is able to withstand the usual drought which commonly occurs in those northern climates in May. Being rooted at least 2 inches deep, it is not so easily blown out or injured by the wind, which usually blows strongly from the west or southwest during spring months. Many failures to secure a stand of clover on the jack pine plains are due to shallow spring seeding and the drying up blowing out of the plants by the persistent western winds com early in the year.

Another point in this connection is that by seeding 2 inches de the clover rootlets, after elongating an inch or so, come into immedia contact with the body of humus produced by turning under the m of wild vegetation 4 inches deep at the time of breaking in Ju Practically all of the available plant food of the soil is thus with easy reach of the clover rootlets just at a time when the plants weakest and stand most in need of it. This decayed matter gi the clover plant a vigorous start until tubercles can be formed the roots and the plants thus made able to secure their nitrog from the air. The fact is now generally known to all farme that the more tubercles or nodules found on the roots of the clove plant the greater the growth of the clover and the more valuable th crop for green manuring.

The seeding of the clover alone without any nurse crop whatev is especially advantageous on these light soils. It insures, in so f as it is possible by any method of farming to insure, a full stand clover and after the land becomes fertile enough the production a fair hay crop that same season. By this method of seeding, all th moisture of the soil and all the available plant food in the soil are p at the service of the clover plant.

When the clover is seeded with a grain crop it must compete w the grain crop for both moisture and food. The result is usua an inferior, unprofitable crop of grain and frequently only a ha stand or an entire failure of the clover. Weeds which in other tions of the country may hinder the growth of clover seeded alone spring do not make trouble on this new land when broken up in s summer and occasionally cultivated.

SEEDING CLOVER WITH A NURSE CROP.

The financial conditions of many farmers who move on the ja pine lands are such that they must grow their own forage and gra in sufficient quantities at least for their own stock. With most far ers on the jack-pine plains the need is immediate of growing money crop as quickly as it can be secured. For these and reasons it will be found necessary to grow a certain amount of gra forage, and root crops from the start, drawing on the fertility air in the soil for their production. At the same time it is desirable t the ground be seeded with clover, so that the building up of the may be begun as quickly as possible.

With a favorable season, particularly one with plenty of rainfall, a good stand of clover may be secured by seeding with grain. In fact, it should be an invariable rule on the jack-pine lands always to seed clover with every grain crop put in. The clover may fail sometimes as a crop, but enough will usually catch to make it profitable to turn under for green manure and thus pay for the seed at least. Winter rye is a favorite crop to seed with, since it usually gives a larger yield on the light lands of this section than any other grain. If the land is broken up in July, as previously described, it will be in good condition for seeding to winter rye about August 25 to September 5 anywhere north of central Michigan and Wisconsin. This is a little too late to seed with clover, which should be put in as soon as the snow goes off the following spring. There are right and wrong methods of doing this.

As to the right method, as soon as the ground can be worked in spring run over the rye field with a spike-toothed harrow lengthwise of the rows. Sow on mammoth clover seed at the rate of 3 to 4 quarts, or 6 to 8 pounds, to the acre. Then run over the field again with the spike-toothed harrow with the teeth slanting back a little and follow with the roller. If the season is dry, cut the rye for hay and give the clover a chance.

This quantity of clover seed is entirely sufficient where it is intended to cut the clover for seed the following year. If the crop is intended for forage, then 6 to 8 pounds of orchard grass or timothy seed sown with the grain in the autumn will insure a larger hay crop the following year.

The harrowing will not injure the rye in the least, and it will cover the clover seed a little deeper than when sown on top of the ground and then dragged in. It is inviting failure to seed the clover on top of sandy soils and not harrow it in.

If wheat is sown in the fall instead of rye the wheat should be harrowed in the spring and the clover sown in exactly the same manner as noted for rye. Seeding clover with spring grains has been practiced by a large number of successful farmers on the jack-pine lands. This method has been quite successful during the past three or four wet years. But where the main purpose is to secure a crop of clover, this method is never so certain as seeding the clover without a nurse crop.

Perhaps three-fourths of the farmers visited on the jack-pine lands consider buckwheat one of the best grains to seed with; that is, they report the best catch of clover with this crop. Clover has also usually caught better in spring rye than in spelt or oats. In many instances also good catches have been secured with Canada field peas. Excellent catches have also been secured when clover was seeded in ruta-bagas in July. In fact this is one of the best crop of all to seed with when the ruta-bagas are sown in rows, the clover being planted between the rows at the last cultivation about the middle of July. For the region about Roscommon, Mich., Mr. F. L. De Lameter recommends the seeding of clover with oats or spelt up to May 15; with millet, buckwheat, or turnips up to June 20: and with rye or wheat up to August 15.

When clover is seeded with any of the spring grains it is safe and advisable to drill the clover in with the grain, letting the clover seed run down the grain tubes. This puts the clover seed down 2 to 3 inches deep, which is none too deep on light land. If the grain is broadcasted by hand, the clover seed, of course, is dragged in the same depth as the grain. In any case, whether the grain is drilled or harrowed in, it is advisable to follow the drill with a heavy roller to pack the soil down firmly around the seed, followed by a spike-tooth harrow to leave the topsoil rough and loose. A rough soil drifts much less than a smoothly packed soil, and moisture is retained to a greater extent when the topsoil is loose than when it is firmly packed down.

It should be a rule on the jack-pine lands to sow on clover seed at every opportunity, with every grain and grass crop, in the standing corn at the last cultivation, with ruta-bagas or turnips, and with every crop with which it will not interfere. As one farmer expressed it "Every time you scratch the ground, put in clover seed." But in dry or otherwise unfavorable seasons all the clover thus seeded may fail. In addition, then, to the clover thus seeded it is strongly urged that the main fields of clover, the ones in the regular rotation that are being depended upon for clover seed, be seeded alone. This method of clover farming insures a seed crop every year on a third to a fourth of the whole farm.

CLOVER INOCULATION.

When new land on the jack-pine plains is cleared and put into clover for the first time, it sometimes makes only a small growth. This is not necessarily because the land is poor, but is often because the soil is not well inoculated with clover bacteria.

In a thrifty clover field the roots are usually thickly studded with small tubercles. When clover is grown on virgin soil like the jack pine plains, the organisms causing these tubercles are not plentiful or may be entirely wanting. In an examination of a number of fields of clover on the plains land many cases were found where there was only now and then a tubercle on the roots, or the tubercles might be entirely absent.

Now, the poorer the land the greater the need is of having the soil well inoculated with the bacteria causing these tubercles. It is by means of bacteria working within these tubercles, or nodules, that the clover plant is able to utilize the nitrogen of the air in its more rapid and vigorous growth.

There are three common ways of getting the soil inoculated with clover bacteria:

(1) When the seed is sown in the usual way nearly always some of the plants become inoculated. This is particularly true where old logging or other roads cross the fields. The field as a whole may be unsatisfactory. If this field is plowed and harrowed and clover immediately sown on again the chances are that the second crop will be much more vigorous than the first, because of the more abundant inoculation of the soil brought about by the greater distribution of the bacteria in the soil by plowing and harrowing, by the wind, etc. So if clover does not succeed the first year, it may be tried on the same land the second year. By the third year the field should be thoroughly inoculated and a good stand obtained. After that the field should remain inoculated for years.

(2) A second and very common way of inoculating new land with clover bacteria is to take moist topsoil from an old clover field and scatter it over the new field at the time the clover is seeded. About 200 to 250 pounds of this old clover soil should be scattered on each acre of new ground and immediately harrowed in. If the inoculated soil dries out, the vigor of the clover bacteria in it is greatly diminished. This is one of the reasons why it should be harrowed in and not simply scattered on top of the ground. Excellent results have been reported by this method of inoculating clover. The danger in this method lies in the possibility of introducing weed pests or plant diseases through the agency of the old soil.

(3) The most scientific method of inoculating the clover field is to obtain a pure culture of clover bacteria and moisten the clover seed with it just before sowing. These pure cultures have been put on the market commercially and can also be obtained in limited quantity from the United States Department of Agriculture.[a]

EFFECT OF WINDS ON THE CLOVER CATCH.

Throughout northern Michigan, Wisconsin, and Minnesota there is usually a persistent strong wind that blows steadily from the west and southwest nearly every day in spring and early summer. These winds are frequently very injurious to spring-planted grains on sandy lands and are especially severe on new clover seeding. Grain fields have been seen where practically all the seeding on the eastern side of the field had been destroyed by drifting sand and the drying effects of the wind. Frequently the clover in exposed fields is entirely killed out, except in sheltered spots like ravines and on hillsides or along fences which break the force of the wind. Time and time again the clover crop in the middle and east side of a field has been found a complete failure while an excellent stand was obtained on the western edge of the field where perhaps a board fence or a few scattering shrubs offered some light protection from the drying winds.

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[a] Information as to methods of inoculating soils for various legumes and the benefits derived from inoculation is given in Farmers' Bulletin No. 314, which may be had free upon application to the Secretary of Agriculture.

In experimental work on sandy lands in Wisconsin, Professor King[a] found that, with a gentle breeze blowing, evaporation a foot above the ground was 25 per cent greater 20 rods out from the west edge of a field than it was 3 rods out. In this case there was a wind-break 12 to 15 feet high on the west side of the field. Even with only a hedge of scattering bur oaks 6 to 8 feet high, evaporation was 30 per cent greater 300 feet to leeward of the hedge than at 20 feet.

Not only does the land dry out much more rapidly with a strong wind blowing over it, but the finer portions of the soil itself may be blown away, greatly decreasing the soil fertility and lessening the power of the soil to hold moisture, for the finer the soil the greater its moisture-holding capacity. These various factors—the wind carrying sand particles which cut off the young plants or cover them over, the more rapid drying out of the soil exposed to the high winds of the spring, and the lessened fertility content of the soil caused by the finer particles being blown away—all tend to decrease the chances of success of the clover plant.

Another point in this connection is that under ordinary conditions of farming the finer particles of soil are brought to the surface every time the land is plowed or tilled. The wind carries many of these away, so that the natural tendency of these soils, if allowed to drift, is to become coarser, less able to retain moisture, and more subject to drought. Besides, in these coarser soils any vegetable matter that may be added in the form of green or stable manure is much more quickly burned out and the humus reduced to ashes than on the finer and more compact soil of the original field. This we do not want. A big yield on these lands depends upon there being a large quantity of humus in them.

WIND-BREAKS FOR SANDY LANDS.

The chances for securing a good catch of clover and a stand of grains are greatly increased by having a wind-break around each field. This can be easily provided by leaving an uncut strip one to two rods wide around each field at the time the land is cleared. Any blank spaces in this hedge can be filled in by transplanting to it some of the native trees and shrubs, such as jack pines, poplars, Juneberries, scrub oaks, willows, and the like. Spruce also does remarkably well on all jack-pine land and makes an excellent wind-break.

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[a] Wisconsin Agricultural Experiment Station Bulletin No. 42.

Since also the prevailing winds come from the west and southwest, it is advisable to make the cleared fields comparatively long and narrow, the long way running north and south.

Many a farmer likes to see big fields. It is a pleasure to stand in the doorway and look over the whole farm, seeing nothing but cultivated fields. An overgrown fence row is an abomination that must be grubbed out. Nevertheless the farmer who fails to leave or provide a wind-break around his fields on the sandy lands of the jack-pine plains pays dearly for his negligence. It is one of the little things that make the difference between success and failure on these lands. A hedge row growing around a sandy field is a kind of insurance against failure, especially valuable where success is staked on the clover crop. What may seem like shiftlessness in overgrown fence rows on fertile clay loam farms has been found to be the wisest kind of farming on lighter sandier lands.

Long, narrow fields never more than 40 rods wide, with occasional wind-breaks, are recommended. In most cases the wind-breaks are already in place. They should not be cut down when clearing the fields. If they are not there they should be planted. This will pay a bigger interest on the investment than any other improvement that can be put on the place.

ROUGH FIELDS DESIRABLE ON SANDY LANDS.

Another point bearing on the relation of winds to the method of handling sandy lands may need explanation. After seeding any crop on sandy lands, the packing of the soil down firmly around the seeds by running over the field with a heavy roller is strongly recommended. Soil moisture from below rises more rapidly in firm than in loose soil, resulting in a better and quicker germination of the sown seed. If, however, the soil is left packed to the surface, evaporation from the soil is more rapid than where the topsoil is loose. Besides, where the soil is left smooth after the roller the winds blow over it much more rapidly than where it is left rough.

King[a] found that the force of the wind next to the soil surface was reduced about one-half on rolled land by running over it with a harrow. He cites a rolled field over which the wind was raising such a dust that it was almost impossible to see across it. A harrow was run over the field at right angles to the wind, when the cloud of dust practically subsided. Actual measurements showed that the velocity of the wind across the roughened field next the soil surface was much less—practically half less—than over the rolled smooth soil. Therefore, whenever the soil is packed down smooth with a roller—and this should be after every clover and grain crop is seeded—it should be followed immediately with a spike-tooth harrow to leave the top surface loose and rough.

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[a] Wisconsin Agricultural Experiment Station Bulletin No. 42.

HANDLING CLOVER FOR SEED.

The usual custom in the north-central part of the southern peninsula of Michigan, where clover is being grown quite extensively for seed on pine and hardwood lands, is to cut the first crop of the season of either common red clover or the larger growing mammoth clover for seed. This is contrary to the general practice in the older clover seed sections farther south, where the usual procedure is to cut the first crop of common red clover for hay and the second for seed. Indeed, the belief is quite prevalent among farmers in the older clover sections that the first crop of June clover does not set seed. That the belief does not hold true in northern Michigan is shown by the fact that there are many authentic records of yields of 6, 8, 10, and, in one instance at least, even 12 bushels of clover seed per acre. These yields have been obtained from the first crop without either clipping or pasturing the clover back in spring. The average yield of clover seed in northern Michigan in fields with a uniform stand of clover is more than 2 and very close to 3 bushels of seed to the acre one year with another, while the better farmers will average 4 to 5 bushels. When, however, in that northern section, the first crop of common red clover is cut for hay and the second left for seed, the seed yield is nearly always disappointing, a yield of half a bushel to a bushel of low-grade seed containing a very large percentage of light and shriveled seed being the rule.

The farmers, however, who are uniformly getting the largest yields of seed in northern Michigan, Wisconsin, and Minnesota are the ones who first pasture back the clover, either common red or mammoth, with sheep or cattle until about June 15 to 20 in a normal season and then let the crop come on for seed. Some farmers who do not have sufficient stock clip the clover back with a mower about June 15 and get as good results as where the clover is pastured off. The mower is set high and the clippings left to fall back on the land. Even where the land is pastured off many farmers practice running over the field with a mower after the stock is removed to clip back any bunches that may be left, so that the crop may come on evenly over the entire field.

The past season, especially, it was a noticeable fact in northern Michigan that those farmers who pastured or clipped back their clover got larger yields of seed than those who did not. One instance from this year's observation may be cited in this connection. One farmer on the jack-pine plains in northern Michigan had a practically perfect stand of clover on about 50 acres of his farm. This clover was waist-high and full of blossoms in July, promising an extra heavy yield. It thrashed out a little more than 2 bushels of seed to the acre. A near-by farmer on similar sandy lands pastured back his rather poor stand of clover on a 40-acre field with cattle until June 20. This field averaged about 5 bushels of seed per acre.

REASONS FOR PASTURING CLOVER OR CLIPPING IT BACK.

Farmers have found from experience that by pasturing or clipping back clover and then letting the crop go to seed they get larger yields of seed generally than by any other method of handling the crop. The reasons generally given for such better yields are about as follows: By clipping or pasturing back, the clover is brought into bloom in a dry time. One farmer expressed it thus: "I don't care how much rain there is up to the time clover blooms, but after that a good seed crop depends upon dry weather." If rainy weather prevails during the blooming period the clover crop may as well be cut for hay.

Again, it is believed that by pasturing or clipping back, the plant does not grow so rank, is less likely to lodge and fall down, blooms more freely, and that a larger number of insects are present to cross-fertilize the crop than earlier in the season. Another advantage of pasturing back is that there is much less straw to handle at thrashing time. This is an item of special importance where the large mammoth clover is grown. A rank yield of plant and a large yield of seed do not appear to go together, but rather where the plant is rankest there the seed yield is least.

THE CLOVER-FLOWER MIDGE.

More pertinent, probably, than all the reasons previously given for pasturing or clipping back clover is the fact that by so doing the destructive action of the clover-flower midge is largely avoided. The clover-flower midge is usually noticed on the clover heads as a small orange-red insect about as large as a pin head, commonly present in all clover sections of the United States and observed by the writer the past season in northern Michigan, Wisconsin, and Minnesota. This insect feeds within the florets of the clover blooms at blossoming time and prevents the formation of seed. It probably does more to injure the seed crop than all other agencies combined except wet weather.

A detailed description and life-history account of the flower midge can not be given here, but the farmer who may be interested in clover-seed production is urged to write to the United States Department of

Agriculture for Bureau of Entomology Circular No. 69, entitled "Some Insects Affecting the Production of Red Clover Seed."

FACTORS IN SUCCESSFUL CLOVER-SEED FARMING.

Practice and science unite in showing that to secure the largest crop of clover seed the crop should bloom during dry weather. This necessitates keeping an account of the weather in each locality from year to year so as to know at about what period to expect dry weather. The plants should be comparatively thin on the ground and stocky for the largest yield. Closely crowded plants make weak stems which lodge and produce very little seed. Pasturing or clipping tends to make short straw and stocky plants, which are less likely to lodge and easier to handle at thrashing time. To avoid the greatest injury from the flower midge the crop should be brought into bloom a little later than the first crop of common red clover normally blooms and considerably earlier than the second crop of this clover usually blooms. This is brought about by pasturing the clover back until about June 15 to 20 in the northern part of Michigan, Wisconsin, and Minnesota, or clipping it back with the mower at about this time.

HARVESTING AND CURING CLOVER FOR SEED.

Practice varies as to the time for cutting common red and mammoth red clover for seed. The greatest quantity of seed is usually obtained by waiting until about 95 per cent of the heads are a dead, brown color, but before any of the heads begin to fall to pieces. A number of instances came under the writer's observation the past season where the crop was cut a little on the green side with the expectation that the seed would ripen up in curing. The results were quite uniformly unsatisfactory, much of the seed being shriveled and light. When the crop is left until most of the heads are thoroughly ripe there is less loss of heads if the cutting is done in the early morning and late afternoon when the straw is a little tougher than at midday.

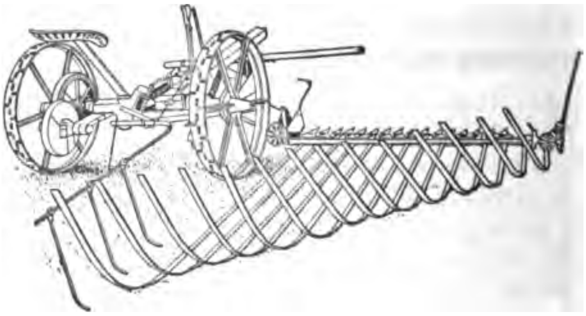

FIG. 1.—Mower with attachment for bunching clover cut for seed.

In cutting, farmers quite generally use a finger-like attachment to the mower with a trip worked by the foot. (See fig. 1.) This leaves the clover in bunches out of the way of the trampling of the horses

After five or six days' curing in these bunches, if the weather conditions are favorable, the crop is thrashed direct from the field. One or wo rains on the crop do not injure it, but with continued wet weather many seeds sprout and the quality of the crop is injured. If a clover uller is not available as soon as the crop is dry enough to hull, the lover should be stacked or put under cover in barns or sheds. When tacked or put into the mow the clover undergoes a sweating process. On this account hulling should be delayed at least three weeks after tacking.

Stacking is always a safe way of handling the clover-seed crop. Fall rains of a month to six weeks' duration are not infrequent in he Northern States, during which time if the clover is lying in the ield the greater part of the seed is lost by the heads rotting off or disintegrating and by the seeds sprouting and becoming discolored. The stack must be covered with straw, marsh hay, or the like, to turn water. The crop is too valuable to take chances with, and the extra abor involved in stacking is not too much insurance to pay for the certainty of securing the crop in the best possible condition.

CLOVER STRAW.

When clover is cut for seed and cured quickly without rainfall he straw has some feeding value. Some farmers use it as a substitute for hay for sheep and cattle. If not required to eat it up too close, stock get along on such material about as well as they do on oat straw. But where the clover has lain in the field subject to dews and rains it gets more or less brittle and rotten and should be used only for bedding or manure.

Many farmers who thrash directly from the field spread the straw out thinly over the field as a manure. For this purpose it is worth about $8 a ton; that is, the amount of fertility in a ton of clover straw if bought in commercial form would cost $8. When this material is used as a light top-dressing on grain it aids in securing a stand of clover; in fact, the straw frequently contains considerable quantities of unthrashed seed which helps considerably in reseeding either old or new fields where it may be applied.

CLOVER FOLLOWING CLOVER.

Clover being the most paying crop yet found for the jack-pine lands, can it be grown year after year on the same land? Mr. Hubbard Head, of Roscommon County, Mich., has asked this question of the jack-pine lands and has been answered in the affirmative. For as many as fifteen years Mr. Head has grown clover continuously on the same fields, and the crop of 1907 was perhaps the best of all. Indeed, by the continuous culture of clover the naturally loose, sandy soil had become firm and compact, the color of the soil decid darker, and its fertility greatly increased.

On this farm the general plan is to cut clover for hay or seed u the clover in the field becomes thin; then to let the crop grow u about July, when the whole crop is turned under and the field ro and reseeded to clover. The seed is sown at the rate of 3 quart the acre and harrowed in about 2 inches deep. Thus handled it h become possible, as the land has improved, to secure two, and so times three, clover crops in succession before it is found necessar plow the field down again and reseed. Likewise it has become p ble to seed such old clover land in early spring and get a crop of or even a small crop of seed the same season.

Frequently, however, bluegrass—or, as it is generally known in Northern States, June-grass—gets into the clover field and be a pest, so that before the field is reseeded to clover it will be fo best to put it into some cultivated crop, such as potatoes or corn, f a year or two. It is probable also that if the farm is near a r road town more money can be made one year with another by al nating potatoes or other vegetable crops with clover than by grow clover continuously. Twelve to fifteen miles away from a railro the growing of clover for seed alone may be the most profitable f of farming, in which case as much as possible of the farm sho be continuously in clover.

MANURES AND FERTILIZERS.

MANURES.

The man who has even a small quantity of manure to apply on jack-pine land will be astonished at the result. In this light, w soil the full value of the manure seems to be effective on the crop once. The crop comes up vigorous and strong, with a healthy co and makes a rapid growth to maturity. When one is growing cl for seed the best method of applying the manure is as a comp tively light top-dressing on meadows in spring. When clover seeded with grain in the spring the chances of success of the c crop are greatly increased by a light top-dressing. An applic of even 3 or 4 tons an acre has a marked beneficial effect and pr cally makes certain a full stand of clover where the manure is e spread over the surface.

When corn or potatoes are grown after clover sod, the sod should plowed under in the fall and what manure is used should be ap as a top-dressing in the spring. In the case of either of these cr the manure can be lightly disked in. When clover is seeded standing corn—a very desirable practice—the manure used as a t dressing is of decided advantage in securing a good stand of clo

Now, there is a difference in manures. The solid matter excreted contains barely half as much plant food in it as the solid and liquid manures combined. One of the first things the plains farmer needs to look after, then, is water-tight stalls and gutters and the use of enough bedding to absorb all the liquids. After the manure is made, the sooner it is applied on the land the more value the crops will get out of it. The best method of producing and caring for manure is told in another bulletin of this Department, which may be had for the asking.[a] Here we wish to emphasize only the desirability of saving the liquid as well as the solid manure by having water-tight floors and gutters, and using the manure in frequent light top-dressings rather than occasional heavy applications turned under.

FERTILIZERS.

Commercial fertilizers have scarcely been used as yet on the jack-pine plains. Superphosphates in a few instances have been found very beneficial to clover, more so than barnyard manure, but on grasses top-dressings of barnyard manure have given larger increases than when superphosphates were used.

Quite extensive experiments a few years since were made by Dr. R. C. Kedzie,[b] of the Michigan Agricultural Experiment Station, in using marl, plaster, and salt on jack-pine lands. Marl had an immediate and lasting beneficial effect on the plains and no injury resulted from its free application at any time. Marked benefit resulted from the use of land plaster up to 200 pounds an acre on nearly all crops, but no benefit was found with any crop from the use of salt as a manure. Splendid results are also being reported on the use of commercial fertilizers by the Wisconsin subexperiment station located in the northern part of that State, at Iron River, on a very good quality of sandy cut-over pine and jack-pine land.

SUMMARY AND SUGGESTIONS.

(1) There are millions of acres of jack-pine lands in Michigan, Wisconsin, and Minnesota that can be made into profitable farms if special care is taken to till the soil properly and follow a type of farming suited to the locality and soil.

(2) The successful farming of these lands is based on the fact that clover will grow on them.

(3) A type of farming which is proving profitable on these lands is the growing of clover for seed.

(4) The kind of clover that grows best and gives the largest yields of seed is the mammoth variety.

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[a] Farmers' Bulletin No. 192, entitled "Barnyard Manure."

[b] Report of the Michigan State Board of Agriculture, 1889.

(5) The most certain way to succeed with the clover crop is to break new ground shallow in midsummer without burning over, cultivate with a disk harrow, sow the seed 2 inches deep the following spring without a nurse crop, cover with a heavy roller, and then run over with a light spike-tooth harrow to leave the topsoil loose and rough.

(6) The best time to break new ground on the jack-pine plains is during July, after the native vegetation has made its maximum growth for the season. Breaking should be done shallow—not more than about 4 inches deep.

(7) The chances for a successful clover catch are greatly increased by making the fields comparatively narrow east and west, and leaving a good hedge of native trees and shrubs along the west and north borders of every field for a wind-break.

(8) The clover crop is greatly benefited on the jack-pine soils by light top-dressings of barnyard manure or of superphosphates. Marl is also beneficial, and land plaster up to 200 pounds to the acre.

(9) Jack-pine lands are not uniform in character. Open plains and light vegetation generally indicate the poorest grade; mixed vegetation, luxuriant on the ground, and an abundance of willows, Juneberries, poplars, maples, briers, etc., indicate better grades. All the better grades of jack-pine lands can be made into profitable farms by growing clover.

(10) It requires an intelligent understanding of the principles of farming to obtain success on these naturally light lands. It takes about three years' time to get the farm on a paying basis. The first year, at least, the settler must have enough money on hand to carry him through, or he must be prepared to work out part of the time.

(11) If the settler will get his land into mammoth clover as soon as he can, keep it in clover as much of the time as possible, and make clover the main crop on his farm for five or six years, he will build up a fertile, profitable farm upon which he can carry out any type of farming suitable to the region.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 324.

SWEET POTATOES.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY, OFFICE OF THE CHIEF,
Washington, D. C., March 2

SIR: I have the honor to transmit herewith a manuscript entitled "
Potatoes," by Mr. W. R. Beattie, Assistant Horticulturist, and re
that it be published as a Farmers' Bulletin to supersede the former
tion of this title issued as Bulletin No. 129 of the same series.

The sweet potato is now one of the most important of our truck
has a wide range of utility, both as a money crop and for home
and it is especially adapted to growing on the "worn-out" cotton and
lands of the Southern States.

Respectfully,

B. T. GALLOW
Chief of B

HON. JAMES WILSON, *Secretary of Agriculture.*

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B. P. I.—359.

SWEET POTATOES.

INTRODUCTION.

With the passing of each year the sweet potato is becoming of greater importance as a commercial truck crop in the United States. During a long period it has formed one of the principal sources of food for the people of the Southern States and of tropical America. As a commercial truck crop the sweet potato would be included among the five of greatest importance, ranking perhaps about third in the list. As a food for the great mass of the people living in the warmer portions of our country the use of this crop is exceeded by hominy and rice only. In many of the islands of the Pacific, especially in the Philippines, the sweet potato is the principal vegetable food for large numbers of the lower classes, at certain seasons being almost the only food available.

The sweet potato industry in this country is readily divided into two classes of production: (1) For home use and (2) for market. A quantity sufficient for home use can be grown under a wide range of conditions, while production on a commercial scale is somewhat restricted by climate and soil and also by market and transportation facilities. The larger eastern markets are now well supplied, but there are sections where the people have not as yet become accustomed to the use of sweet potatoes in large quantities. The field for the production and use of sweet potatoes is very broad, and this crop promises to become of more general farm importance.

In view of the constantly increasing interest in sweet potatoes it is the purpose of this bulletin to give simple cultural directions covering their production both for home use and for market, including the soil and its preparation, the propagation of the plants, planting, harvesting, storing, and marketing, together with the uses of sweet potatoes for stock feeding and for similar purposes.

The sweet potato is of a tropical nature, its original home probably being the West Indies and Central America. The true sweet potato, as we have it growing in the United States, belongs to the morning-glory family, its botanical name being *Ipomoea batatas*. Throughout the Southern States the sweet potatoes having moist fle commonly known as "yams" and those having dry flesh as potatoes. The name "yam" is misleading and properly belong a distinct class of plants that are confined almost entirely to Tropics.

AREAS ADAPTED TO SWEET POTATO CULTURE.

Owing to the tropical nature of the sweet potato it natur thrives best in the South Atlantic and Gulf Coast States, but it be grown for home use as far north as southern New York and w ward along that latitude to the Rocky Mountains. The areas su to commercial production, as indicated by the shaded portions of map shown as figure 1, extend from New Jersey southward and w ward to Texas, and are found again in the central valleys of C fornia. In the Mississippi Valley the commercial area exten far north as the southern part of Iowa, Illinois, and Indiana. T region around Louisville, Ky., is noted for excellent crops of s potatoes.

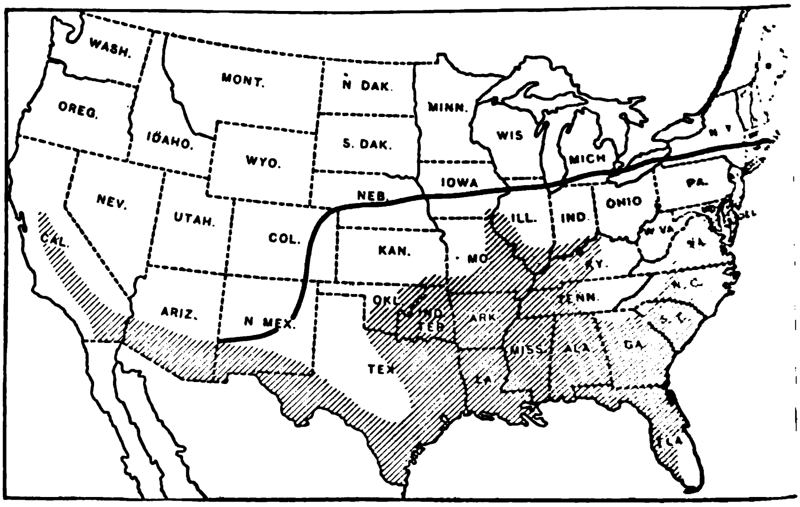

FIG. 1.—Map showing range of production of sweet potatoes. The shaded porti sents the area adapted to commercial growing. The dark line represents the limits of sweet potato culture for home use.

CLIMATIC CONDITIONS REQUIRED.

The climatic requirements for the production of sweet potat a commercial scale are (1) a growing period of at least four a half months without frost, (2) warm nights and abundant sun during the day, and (3) a moderate rainfall during the grow period.

Where irrigation is depended upon for the supply of moisture, the eatest quantity of water should be applied between the time the nts are set in the field and the time when the vines practically ver the ground. If too much water is applied during the latter rt of the season the result may be an abundant growth of vine and mall yield of stringy potatoes. For some time before harvesting crop the water should be withheld altogether, in order that the ts may ripen properly.

The climatic conditions prevailing throughout the shaded portion the map (fig. 1) are well suited to the requirements of the sweet tato, except that irrigation is necessary in the western part, including a portion of Texas.

CHARACTER OF SOIL ADAPTED TO SWEET POTATOES.

Sweet potatoes thrive on a moderately fertile sandy loam which es not contain an excess of organic matter. They are frequently own upon almost pure sand, especially where the subsoil is a yelw clay. Soils containing a considerable amount [illegible] with nestone are well apted to the owing of the op. The sweet tato is exceptional in that a irly good crop n be grown on soils that are o poor for the roduction of the ajority of farm ops. Sweet potatoes yield a fair op on the "worn-out" tobacco and otton lands of the outh, especially hen used in a otation including ome leguminous rop for increasing he humus in the soil. Like many other crops, the sweet potato hrives on newly cleared land, but [illegible] continuously in the same place. [illegible] ther crops, rotation is the [illegible]

[illegible]

Good drainage is essential, the original idea of planting upon ridges being for the purpose of securing better drainage. Th face soil should extend to a depth of 6 or 8 inches, and the su should be of such a nature that it will carry off excessive mo without leaching away the fertilizers applied to the land. Too g a depth of loose surface soil or an alluvial soil having no subsoil produce long, irregular potatoes that are undesirable for mark Planting upon land having a loose, sandy surface soil underlai a well-drained clay subsoil will tend to produce the type of thick, spindle-formed potato that commands the highest price. T type is illustrated in figure 2, which shows a hill containing marketable potatoes. The depth of plowing is a prominent facto the preparation of land for sweet potatoes, and on soils of too g depth before the subsoil is reached very shallow plowing should practiced, leaving the soil firm beneath, against which the roots force their way. If the surface soil is of insufficient depth, it sh be gradually increased by plowing a little deeper each year or by soiling in the furrow behind the regular turning plow.

FERTILIZERS FOR SWEET POTATOES.

As already noted, the sweet potato will thrive on soils that are moderately fertile. The root portion of the plant is the part hav the greatest value, though the foliage and vines have some valu food for certain kinds of stock. It has been found that an exce amount of organic matter in the soil will frequently produce abundant growth of vines at the expense of the roots. It has al been noted that the potatoes will be small and the yield unsatisfact on soils that do not contain sufficient organic matter to produce a f growth of vine.

USE OF STABLE MANURE.

The use of stable manure as a fertilizer for sweet potatoes is rec mended on lands that are deficient in organic matter. Heavy a plications of fresh manure shortly before planting the land to sw potatoes will stimulate not only the growth of weeds but also of vines at the expense of the roots. Well-rotted stable manure may used at the rate of 10 to 15 cartloads to the acre, spread broadcast beneath the ridges and harrowed into the soil, but it is always well apply the manure with the crop grown the previous season. By t method the manure will become thoroughly incorporated with soil and become somewhat reduced before the sweet potatoes planted upon the land.

Stable manure will be found most beneficial on worn-out soils on the more fertile soils its use should be restricted and the met of application carefully studied. In some sections where the orga matter in the soil is insufficient all kinds of vegetable matter, including manure, pine needles, corn fodder, straw, and stubble, are turned into the land to bring up the fertility. The sweet potato vines will go a little way toward keeping up the organic matter in the soil, but have a souring tendency and should be accompanied with a moderate application of lime or plaster.

Leguminous plants grown as cover crops or in the rotation will serve to keep up the organic matter in the soil the same as stable manure. Sweet potato growers are coming to realize the value of crimson clover for use in the rotation in which sweet potatoes are grown. If the land is planted to corn, crimson clover may be sown in the alleys at the time the corn receives its final cultivation. This will provide a covering for the land during the winter, and as the crimson clover starts into growth quite early in the spring a heavy crop is produced by the time it is necessary to plow the land for sweet potatoes. In order to secure the best results the crimson clover should be turned under not later than the appearance of the first blooms; if allowed to remain longer the stems become tough and do not decay quickly enough to be of benefit to the sweet potato crop which follows.

USE OF COMMERCIAL FERTILIZERS.

The sweet potato is one of the few of our crops that thrive equally as well (or better) upon commercial fertilizers as upon stable manure. A fertilizer for use on the majority of sweet potato lands should contain 3 to 6 per cent of nitrogen, 6 or 7 per cent of phosphoric acid, and 8 to 10 per cent of potash. Every grower should make a study of the requirements of his soil and apply the fertilizer that will give the best results. Many growers purchase the ingredients and mix their own special fertilizers, or use a standard fertilizer as a base and increase the percentage of certain elements by adding high-grade elementary ingredients. Some soils require that certain elements should be in a more available form than others; in the case of nitrogen it is often desirable to have a portion of that contained in the fertilizer quickly available and the remainder more slowly in order to feed the plants throughout the season.

A mixture adapted to the growing of sweet potatoes on most soils may be made by combining the following:

200 pounds of high-grade sulphate of ammonia, 25 per cent pure.
200 pounds of dried blood, or 300 pounds of fish scrap.
1,200 pounds of acid phosphate, 11 per cent pure.
400 pounds of high-grade muriate of potash, 50 per cent pure.

This mixture contains approximately 4.25 per cent of nitrogen, 6.6 per cent of phosphoric acid, and 10 per cent of potash. Nitrogen in two forms is present, the dried blood being quickly available and the sulphate of ammonia more slowly, becoming available later i season when the potatoes are forming.

Experience has demonstrated the necessity of having an abun of potash in the fertilizers used for sweet potatoes. In exper with fertilizers for this crop an increased yield of from 40 t per cent has been noted on plots where a liberal application of had been made in comparison with plots to which no fertilizer applied. In most cases the highest yield is secured where a com or balanced, fertilizer is used.

QUANTITY AND TIME OF APPLYING COMMERCIAL FERTILIZER

The quantity of fertilizer that may be profitably applied w governed entirely by local conditions. Many growers do not d

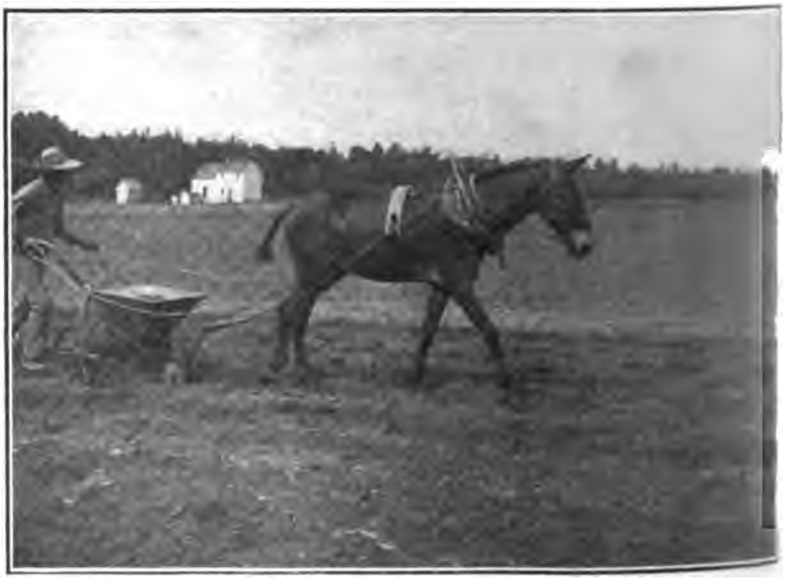

FIG. 3.—A one-horse fertilizer sower in operation.

upon commercial fertilizers, but merely apply from 200 to 300 p to each acre as a supplement to the organic matter and natural tility of the soil. Others apply from 300 to 1,000 pounds accor to the condition of the soil, while a few growers use a ton to the The general rule is to apply the fertilizer in the row where th is to be grown, but where large quantities are used it should be tributed at least ten days before planting and thoroughly in porated with the soil. An application of 1,000 pounds of high g fertilizer placed in the row at planting time has been known to seriously or kill the plants. Hand and one-horse distributers lar to that shown in figure 3, which merely sow the fertilizer in ow, are in use. Others are designed to scatter the fertilizer and ork it into the soil, and tools that mark the land, sow the fertilizer, nd throw up the ridges at one operation can be obtained. For the est results the fertilizer should be applied at least ten days before lanting, or a portion of the fertilizer may be applied a month or ore in advance and the remainder at the time of preparing the land or planting.

USE OF HARDWOOD ASHES AS A FERTILIZER.

Hardwood ashes are desirable for use on sweet potato land and ay be applied at the rate of from 1,200 to 2,000 pounds to the acre. he value of wood ashes depends upon how much they have become eached, but hardwood ashes should contain from 6 to 8 per cent of vailable potash. Wood ashes also contain considerable lime.

USE OF LIME ON SWEET POTATO LAND.

Where large quantities of any green crop are plowed into the soil there is a tendency to sourness, and occasional applications of from 1 to 2 tons of lime to the acre are beneficial. The presence of an abundance of lime in soils devoted to the growing of sweet potatoes hastens the maturity of the crop and increases the yield. On poor soils the lime and potash work together to produce potatoes of uniform size and shape, but on rich or alluvial soils the tendency is toward the production of over-large and irregular roots. The lime should be applied the previous season, or at least the autumn before planting the land to sweet potatoes.

PROPAGATION OF PLANTS.

The more common varieties of the sweet potato have for a great many years been propagated by cuttings, or sets, taken either from the potatoes themselves or from growing vines, and as a result the plants have ceased to flower and produce seed. The greater portion of the commercial crop is grown from sets, or "draws," produced by sprouting medium-sized potatoes in a warm bed of soil. In the Southern States the seed potatoes are frequently cut into pieces in the same manner as Irish potatoes and planted in the row where they are to mature. Where several plants appear in one hill they are thinned, and those removed are used for planting other land. In the South Atlantic and Gulf Coast States the sweet potato is frequently propagated by making vine cuttings. A comparatively small bed of seed potatoes is planted quite early and the sets so produced are used to plant a small patch from which vine cuttings are taken later by the cartload for planting large fields. In the southern parts of Florida and Texas and on the South Sea Islands the potatoes may remain in the soil from year to year, being dug only as required for use, those remaining over producing the sets for the following season's planting.

Where only a small area of sweet potatoes is to be grown for home use, the necessary plants can generally be secured from some one who makes a business of growing them. If an acre or more is to be planted it will in most cases be more economical to prepare a bed and grow the plants. The method of starting the plants will depend upon the locality and the acreage to be planted, the essentials being a bed of warm earth and a covering to protect the young plants during the early springtime.

SELECTION OF SEED.

The care of the seed potatoes during the winter is discussed later under the head of storage of sweet potatoes.

The potatoes that are to serve as seed from which to grow the plants for the next season's crop should always be selected at the time of digging and housing the crop. For seed purposes it is the custom to select the medium or under-sized potatoes, such as are too small for marketing. Those potatoes that will pass through a 2-inch ring or can be circled by the thumb and first finger of a man having a hand of average size are used for seed purposes.

The seed potatoes should be uniform in size and of the shape desired in the following year's crop. The seed should be free from cuts, bruises, decay, or disease of any kind. Throughout the handling of the seed potatoes they should not receive any treatment that would break eggs. The seed should always be handled and kept separate from the regular crop.

The oftener the seed is handled the greater the danger of decay, and it should not be sorted over until everything is ready for bedding.

The best seed is grown from cuttings taken from the regular plants after they have begun to form vines. These cuttings produce large numbers of medium or small-sized potatoes that are free from diseases and adapted for use as seed the following year.

MANURE-HEATED BEDS.

The ordinary hotbed is now in too common use to require a lengthy description, and as constructed by many of the sweet potato growers of the eastern shore of Virginia it consists of one or more long, narrow beds similar to those shown in figure 4.

The hotbeds are generally located where they will have protection on the north by a piece of pine woods, a hill, or buildings, and where no natural protection is available a wind-break consisting of pine boughs or corn fodder is usually erected. In preparing the hotbeds 8 to 12 inches of fresh horse manure are first trampled into the bottom of the excavation, and as soon as this has begun to heat 3 or inches of sandy loam are spread evenly over the manure. The sash or other covering is then put on and the bed allowed to stand until the temperature of the manure falls to about 80° or 85° F. before the seed potatoes are put in.

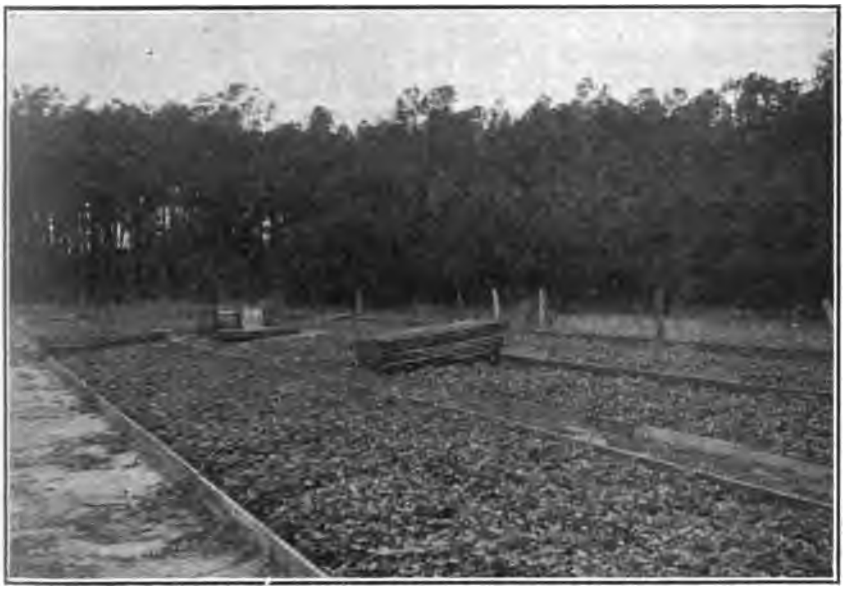

FIG. 4.—A manure-heated hotbed, showing the sash removed and piled where they can be easily placed upon the beds in case of danger from frost. Note the pine woods to the north and west of the plant beds.

KILN OR FIRE HEATED BEDS.

Where large numbers of plants are required and there is difficulty in procuring good manure for hotbed purposes, a large bed may be constructed with arrangements for supplying the heat by means of a brick furnace or a stove. An idea of the general plan of a bed of this kind can be most easily gained by reference to figure 5.

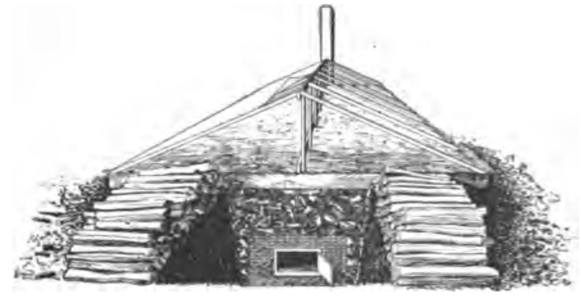

FIG. 5.—A kiln or furnace heated bed. (Redrawn from Bailey's Cyclopedia of Agriculture.)

The side walls should be of stone, concrete, or brick, and a floor of boards upon timber supports is essential. From 4 to 6 inches of fine soil are placed upon the floor before bedding the potatoes, and a covering of about 3 inches of sifted soil or leaf mold is then added. The furnace should be so constructed that it may be fired from the outer or just inside a door opening into the space beneath the bed. T brick furnace extends a few feet only and connects with o more 6-inch chimney tiles which carry the smoke toward the for a distance of 25 or 30 feet and discharge it into the open beneath the floor. At the opposite end from the furnace a chimney collects the gases and carries them to the open air. Ow to the moisture absorbed from the soil by the flooring, there i small danger from fire, but if wood is used for fuel it may be place a screen of wire over the openings of the tiles in order to vent the passage of sparks.

In order to secure a uniform temperature under all parts of the it may be desirable to cover the furnace and horizontal chimney with earth and to so construct the bed that there will be a gra rise of the floor toward the chimney end.

PIPE-HEATED BEDS.

Where a steam or hot water boiler is in use for greenhouse or re dence heating, a very satisfactory plant bed can be constructe burying four or five lines of pipes in the soil beneath the bed supplying the heat from the boiler. This has been found to b ideal method, as the lines of pipes can be controlled by valves and temperature of the soil in the bed kept at the desired point. If water heat is used the pipes should be laid with the soil in direct tact with them, but for steam the pipes should be surrounded w 3-inch or 4-inch t to prevent too r passage of the and the conseq burning of the The pipes should placed 10 or inches below the tom of the sp soil in the bed, 14 to 16 inches b the line of the potatoes. If the pipes are laid 18 inches apart an even distribu of heat will be secured. For hot water heating, 2-inch pipes sh be employed, but 1¼-inch pipes will be large enough for steam, p vided the lines are not more than 60 feet in length. The lines of should be carefully graded and have a uniform fall toward the r turn end; in fact, the rules governing greenhouse heating apply the piping of beds of this kind. A general idea of the construct of a pipe-heated bed may be gained from the cross section sho as figure 6.

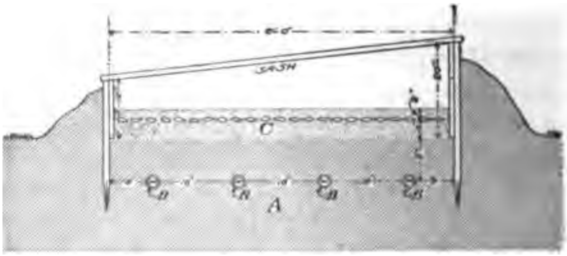

FIG. 6.—Cross section of pipe-heated plant bed. A, natural soil; B, hot water or steam pipes; C, sifted sandy loam or leaf mold.

COVERINGS FOR PLANT BEDS.

Throughout the Gulf Coast and South Atlantic States it may not be necessary to provide a cover to retain heat or protect the plants from cold, but farther north some form of cover should be provided. In the northern part of the sweet potato district glazed hotbed sash, each about 3 by 6 feet in size, are most commonly used. In warmer sections a covering of light canvas or heavy muslin will be sufficient for the protection of the plant bed. Where sash are used they should always slope to the south, in order to admit the greatest amount of light. A canvas or muslin cover should be supported either upon laths or wires in such manner that water will drain off and not form puddles and drip upon the bed. Provision should also be made for rolling up the canvas on bright days to admit sunlight and secure ventilation.

Toward the end of the time that the plants are to remain in the plant bed the amount of ventilation should be increased by leaving the cover off a greater portion of the time, in order to harden the plants to outdoor conditions. After a time the covering may be left off all the time, but it should be kept where it can be put on quickly in case of a late spring frost. No matter how well the sweet potato plants are accustomed to open-air conditions they will be injured by the slightest frosting. The covering for the plant bed will last many years if stored in a dry place during the period that it is not in use. A roof of boards or paper will serve as a covering for the plant bed, but these materials are not so easily handled as are the sash or canvas. Where no regular covering material is available its place may be taken by a layer of fine straw or grass spread evenly over the surface of the bed.

Some growers follow the practice of spreading about 3 inches of fine, fresh horse manure over the bed as soon as the sweet potatoes are bedded; this serves both as a covering and to retain the moisture. When the sprouts begin to appear, a portion of the manure must be removed to prevent the plants from becoming too long and slender.

BEDDING THE SEED.

In the warmer portions of the sweet-potato-growing district the seed should be bedded when danger of frost has passed. In the northern portion of the area the seed should be placed in the hotbed from the 20th of March to the 10th of April, after the temperature of the bed has fallen to 80° or 85° F. and become regular.

If possible, select a warm, sunny day for this work, in order that the seed potatoes and the bed may not become chilled. The soil to be used for covering the potatoes should be sifted beforehand and placed in piles in the bed, where it will have become warm and in good condition for use. Leaf mold is perhaps the best material with which to cover the potatoes, but where this can not be obtained a fine. r sandy loam is the best substitute.

Before placing the seed in the bed, an inch or more of the fi sifted covering material should be spread evenly over the surfa the regular soil in the bed. The potatoes are spread upon this each one being placed by hand so that they will not touch, and a one-half of the bed surface is covered. If extra large pot are employed for seed they may be split lengthwise and placed the cut side down in the bed. When the potatoes are in place, c them to a depth of about 3 inches, water by using a sprinklin and then watch the temperature of the bed carefully until the pot have formed an abundance of sprouts.

TEMPERATURE OF THE PLANT BED.

As noted above, the temperature of the plant bed should be a 80° or 85° F. at the time the seed is bedded, and should grad fall until it remains stationary at 58° or 60° F. at the end of six w or before planting-out time. A thermometer should be kept plun in the soil of the bed and the temperature noted every day for the fi ten days or two weeks. If the manure hotbed is not located in a w drained situation there is danger of soil water getting in with manure and either destroying the heat altogether or starting a s fermentation which will cause the temperature to run too high injure the potatoes. The air temperature beneath the sash or ot covering should run between 60° and 80° F., and during bright d it must be controlled by ventilation. As the time for planting in field or garden draws near, the plants should be given more expo to harden them to outdoor conditions.

MOISTURE REQUIREMENTS OF THE PLANT BED.

The amount of water required by the plant bed will depend s what upon the method of heating employed. With a steam-heated furnace-heated bed more watering will be necessary than if the or nary manure hotbed is used. The watering given when the pota are bedded will generally be sufficient to last for several days after the plants begin to form leaves and the cover is left off du the greater part of the day, watering will be necessary every d The water should never be poured on in a solid stream, but by m of a sprinkling can or a rose, or nozzle, on the end of a hose. W very large plant beds are employed it will be necessary to keep s one in almost constant attendance to care for the watering, heati and ventilation. The success of the crop depends largely upon character of the plants, and proper management of the plant b essential to the production of the right kind of plants.

"DRAWING" THE SETS.

As a general rule sweet potato plants are set in the field shortly after a rain. In order to avoid delay in planting, the hands should begin to get out the sets as soon as the rain ceases falling and place them in crates or baskets ready for transportation to the field. The sets are not all produced at once, and only those that have formed good roots are "drawn," the others being left until later. In "drawing" the sets the seed potato is held down with one hand while the plants are removed with the thumb and finger of the other hand. It often happens that five or six plants will cling together at the base, and these should be separated in order to avoid loss of time in he field. Where plants are to be set with a transplanting machine t is essential that they should be in the best possible shape in order hat they may be handled rapidly by the boys who feed the plants nto the machine. The roots should all be kept in one direction, and f the tops are long or irregular they may be trimmed off even by neans of a knife.

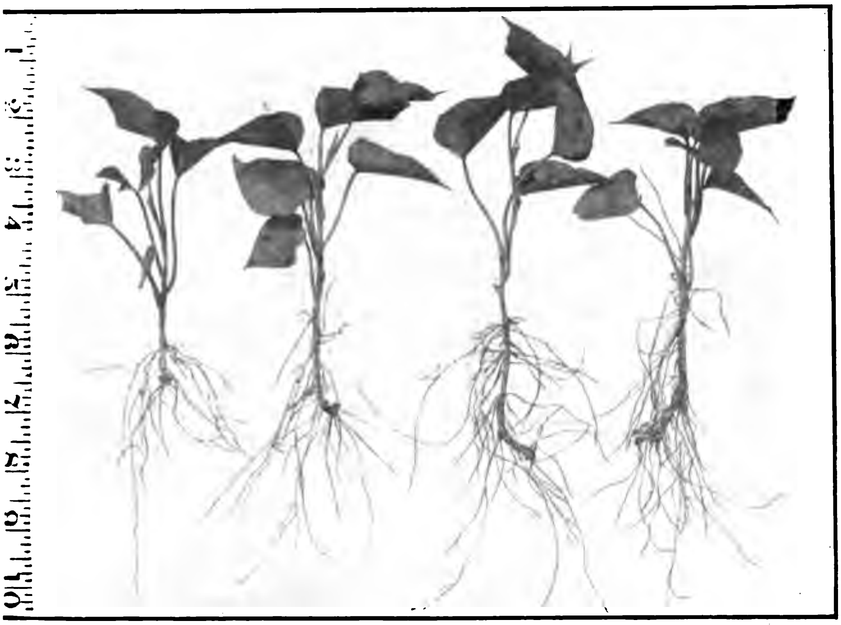

FIG. 7.—Sweet potato sets, or "drawings."

While "drawing" the sets it is a good plan to have at hand a large pail or a tub containing water to which there has been added a quantity of clay and cow manure which has been stirred until it forms a thin slime. As the plants are pulled from the bed they are taken in small bunches and their roots dipped into this mixture. This process, termed "puddling," covers the roots with a coating which not only prevents their becoming dry in handling but insures a direct contact with the soil when they are planted in the field or garden. Figure 7 shows four sets that are at slightly different stages of growth; those on the right are in prime condition for planting. After removing the sets that are ready, the bed should be watered to settle the soil where it has become disturbed and then left for the younger plants to develop.

PACKING PLANTS FOR SHIPMENT.

In preparing sweet potato plants for shipment or for sale, they are "drawn" from the bed and tied in bunches of 100 each with a string. Sweet potato plants will not withstand excessive moisture and should always be packed while the tops are dry. A little damp moss or paper may be placed in the crate or basket and the roots bedded in it, but the tops should remain dry and have free ventilation. If the roots of sweet potato plants are carefully puddled without the mixture coming in contact with the tops, they will keep in good condition for a week or ten days.

PREPARATION OF LAND FOR SWEET POTATOES.

The character of soil devoted to sweet potato culture is generally quite easy to prepare. In preparing land for planting to sweet potatoes the plowing and fitting are practically the same as for corn. It should be borne in mind, however, that the work necessary for thorough preparation will be well repaid by the increased ease in handling the crop later. It is always desirable that a crop of sweet potatoes be grown as a part of the regular farm rotation. In the northern portion of the sweet-potato-growing area the crop will occupy the land the entire growing season, and a three or four year rotation should be practiced. Where the climate will permit, a crop of early snap beans, peas, or cabbage may precede the sweet potatoes, but in any case the land should not be planted to sweet potatoes oftener than once every three years. A good rotation is to devote the land to corn one year, sowing crimson clover in the alleys between the rows at the time the corn is given the last cultivation. During the following spring the crimson clover should be turned under and sweet potatoes planted; then in the autumn, after the potatoes are harvested, the land may be plowed, fitted, and sown to rye or winter oats with plenty of grass seed. In this way a crop of grain may be obtained during the time that the grass is becoming established. Allow the land to remain in grass one or two years and then repeat the rotation. Where corn is followed by sweet potatoes in the rotation, stable manure should be applied while fitting the land for the corn, and commercial fertilizers should be applied with the sweet potato crop.

As previously mentioned, the depth of plowing has considerable influence upon the character of the product. The usual depth of plowing in preparing land for corn will prove satisfactory for sweet potatoes. The fact that sweet potatoes are not planted in the field until quite late in the spring makes it possible for the grower to select a time when conditions are favorable for the preparation of the land. Plowing may be deferred until the soil has become sufficiently dry to break up fine and mellow. It is important that the land should be harrowed within a few hours after plowing; further fitting may be deferred until later, and if the soil is inclined to be lumpy the work of pulverizing may best be done shortly after a shower and while the lumps are mellow. When the primary work of preparation is finished, the soil should be mellow to a depth of 6 or 7 inches and the surface smooth and even. Subsequent handling of the soil preparatory to planting will depend upon whether ridge or level culture is to be followed.

APPLICATION OF FERTILIZERS.

For the general good of the land commercial fertilizers should be applied broadcast, but the majority of farmers feel that they can not afford to do this and that the quantity that they are able to apply will give greater returns when placed in the row. This is a matter for the decision of each grower and will depend greatly upon the capacity of the soil under consideration for retaining fertilizers from year to year.

PREPARATION FOR PLANTING.

After plowing and fitting the land it is generally allowed to lie several days before being put in shape for planting. If level culture is to be practiced, the only thing necessary will be to run the harrow over the soil once and then mark in both directions at the desired distances for planting. The marking is generally done with either a one-horse plow, a flat-soled marker, or a disk marker. The disk marker is well adapted to this work, as it throws up a slight ridge which furnishes fresh earth in which to plant. Some growers who practice level culture mark the ground with a small one-horse plow and throw up a slight ridge upon which to plant; behind the plow a roller is used to compress this ridge to a low, flat elevation.

Where the more universal ridge method of planting is employed the soil is thrown up by means of a turning plow or a disk machine. The ridges should be made at least one week before planting, in order that the soil may become settled and compact. The majority of sweet-potato growers make the ridges whenever the land is in good condition to work and then either roll or drag the tops just ahead of the planters. By using a roller similar to that shown in figure 8 the ridges at one operation can be rolled and marked the proper distances for planting. A drag suitable for smoothing the tops of the ridges can be easily constructed by cleating together three pieces of 2 by 4 inch scantling.

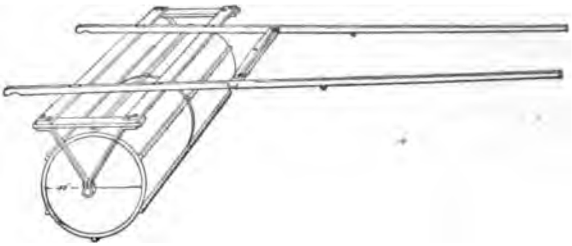

FIG. 8.—Roller for marking distances to plant.

SETTING THE PLANTS.

The success of the crop depends largely upon the way in which the plants start after being removed from the bed and set in the field or garden. Practical growers always plan to set the plants during a "season" or period when the conditions are suitable to a quick start into growth, either just before a rain or as soon afterward as the soil can be worked. The method of setting will depend entirely upon local conditions and the acreage to be grown, the essential features, however, being to get the roots in contact with moist earth and the soil firmly pressed about the plants.

The use of water around the roots of the plants is desirable under most circumstances, as it not only moistens the soil but assists in settling it about the roots. A large quantity of water is not necessary, one-half pint to each plant being generally considered sufficient.

DISTANCES TO PLANT.

Where level culture is practiced, the plants are set from 24 to 30 inches apart in each direction. On the eastern shore of Virginia the greater portion of the crop is planted 24 inches apart each way, requiring about 11,000 plants to an acre. By planting 30 inches apart each way, only about 7,000 plants are required to set one acre. When the crop is grown on ridges it is customary to have the ridges from 36 to 42 inches apart from center to center and to place the plants 14 to 18 inches apart in the row. By this method an acre will require from 8,000 to 12,500 plants. An acre of good sweet potato land will readily support 9,000 to 11,000 plants, and the number most commonly planted by the several methods will fall within these figures.

When planting for level culture the location of the plants will be indicated by cross marks, but for planting upon ridges it is necessary to provide some means of indicating the distances. This may be accomplished in several ways, but a roller of the type shown in figure 8 having cleats nailed at equal distances around its surface is desirable and serves the purpose of both rolling and marking the ridges. Another device is constructed along lines similar to those of the ordinary wheelbarrow, pegs being placed upon the rim of the wheel to mark the planting distances. In using the wheelbarrow marker it is simply pushed along the top of the ridge. Another device of this class is constructed by placing three or four wheels upon a long axle and drawing it with a horse, the wheels being so arranged that they can be set at any point on the axle to provide for change in width of row.

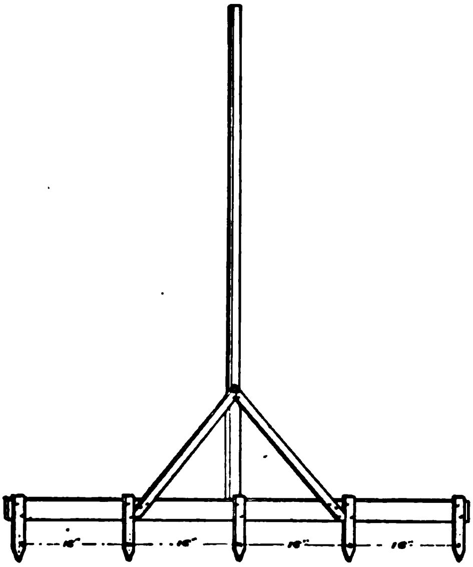

FIG. 9.—Drag or rake marker.

A very cheap and efficient marker can be constructed of 1 by 3 inch laths, as shown in figure 9. This marker can be used to indicate planting distances along one row, or by draging it across the ridges the entire field can be marked before beginning to plant. The machine transplanters are provided with a spacing device which indicates the distance between plants; also with a row marker to show the location of the next row.

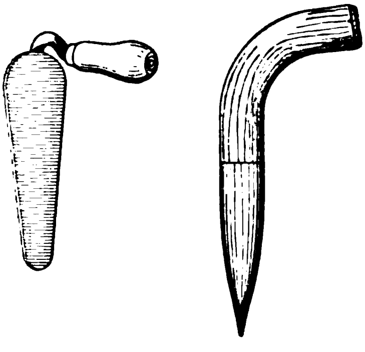

FIG. 10.—A trowel and a dibble used in setting plants.

SETTING BY HAND.

Where a few hundred plants are to be grown for home use or if only an acre or two are to be planted, the hand method of planting will answer every requirement. A trowel or a dibble, as shown in figure 10, is used for opening the soil to receive the plant, and the earth is closed about the roots by a second thrust with the implement, or the heel of the shoe is used to press the earth about the plant. For hand planting, the plants are dropped ahead of the "dibblers" by boys and girls. Seven thousand to ten thousand plants, or an acre, is an excellent day's work for a planter when everything is in good condition. Where a few hundred plants are set in the garden it is

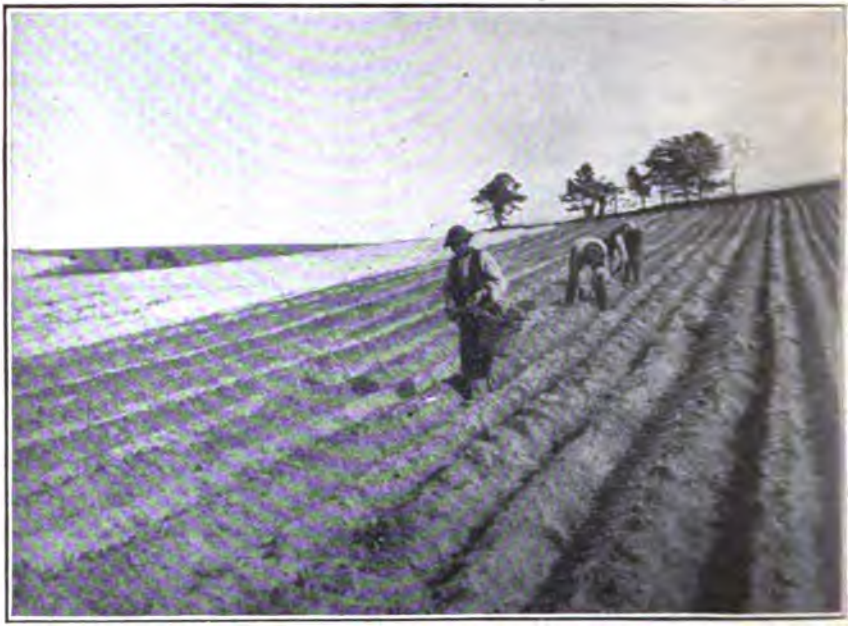

FIG. 11.—Setting sweet potato plants by hand.

always desirable to water them before closing the earth about the plant. Figure 11 shows the method of planting by hand.

PLANTING WITH TONGS.

Setting by hand is at best a back-breaking process, and numerous devices have been invented to save the bending of the body in hand planting. One of the simplest of these is a pair of wooden tongs with which the plant can be caught by the root and thrust into the soil. The plants are either dropped ahead or carried in a small basket strapped to the waist of the operator. The tongs are provided with a spring to throw the jaws apart, and are held in one hand while the plants are inserted with the other hand. In case the plants are dropped ahead, the root portion is grasped between the points of the tongs without the use of the hand.

An implement, known as a shovel, which is sometimes used in conjunction with the tongs, consists of a piece of lath sharpened to a flat point. This is used to open a hole in the soil ready for the plant. In using the tongs and shovel, the plants are dropped as for hand planting. The person doing the setting carries the tongs in the left hand and the shovel in the right. The plants are picked up by means f the tongs, while a hole is made by inserting the shovel in the soil t the point where the plant is to be set. The plant is then inserted nd the earth closed about it either by a second thrust of the shovel r by the foot of the operator. A man who is expert in the use of hese homemade tools can set plants quite rapidly without bending he body sufficiently for the work to become tiresome.

A tool that is sometimes employed where vine cuttings are planted s a long dibble or a cane having a notch covered with cloth or leather n the lower end. The droppers lay the cuttings across the row at he proper distances and the planters place the notch over the middle f the cutting and force it into the soil with both ends protruding. A general idea of these devices may be ained from figure 12.

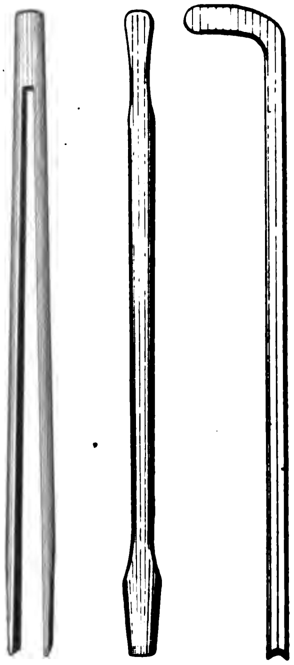

FIG. 12.—Tongs, shovel, and forked dibble for setting plants.

SETTING WITH MACHINES.

Where a large acreage is grown, the work f setting the plants in the field is greatly acilitated by the use of transplanting mahines, of which there are several makes pon the market. The essential features f these machines are a device to open a mall furrow, a tank for the supply of ater, and disks or blades for closing the oil about the plants. With a transplanting machine it is not necessary to wait for "season," as the machine automatically hrows a small quantity of water around he roots of each plant as it is being set. In operating these machines it is necessary o have a steady team and two active boys ho are trained to drop the plants at roper intervals, as indicated by a spacer n the machine. Under reasonably favorble conditions, a machine will plant from to 4 acres a day. In addition to being abor savers, these machines do the work etter and more uniformly than it is ordinarily done by hand.

The plants can be set without the use of water, but the results are ore satisfactory where the water is used. A number of our most uccessful growers use water when setting after a rain, claiming that he water has the effect of settling the soil firmly about the roots of he plants and that they start into growth much more quickly. here the full amount of water is used it will be necessary to proide a man and team to haul the water to the machine, but by this method plants may be set during dry weather without the loss of more than one plant out of every one hundred.

The majority of the transplanting machines are designed for planting either on the tops of ridges or on the level. The cost of setting an acre with one of these machines, using water, should be figured

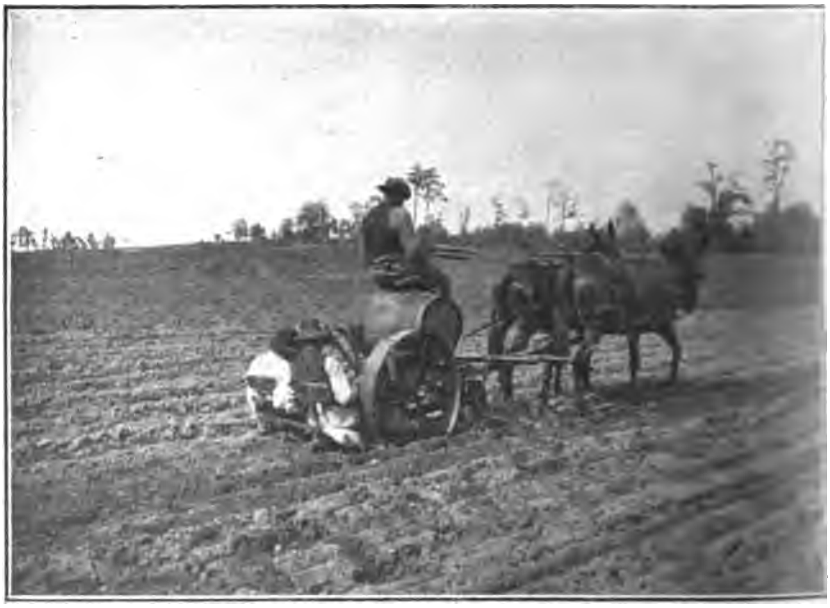

FIG. 13.—Transplanting machine in operation.

on the basis of two teams with drivers and two boys for a period of three or three and one-half hours. If water is not used there will be a saving of at least one team and driver; also the time required for filling the tank on the machine. A transplanter in operation is shown in figure 13.

CULTIVATION OF SWEET POTATOES.

The methods of handling a crop of sweet potatoes do not differ materially from those employed with ordinary farm and garden crops. Within a few days after planting, a sweep or one-horse plow should be run in the alleys to break out the strip of earth left in ridging. The loose earth in the alleys should be worked toward the rows until a broad, flat ridge is formed upon which a small-tooth cultivator can be run quite close to the plants. After each rain or irrigation the soil should receive a shallow cultivation, and during dry weather frequent cultivations are necessary in order to retain moisture

ture. About two hand hoeings are generally necessary in order to keep the rows free from weeds and the soil loose around the plants. As hand labor is expensive, it should be the aim to perform the greater part of the work by means of horse tools. Where sweet potatoes are planted in check rows and worked in both directions the hand work required will be reduced to a minimum, but a certain amount of hoeing is always necessary.

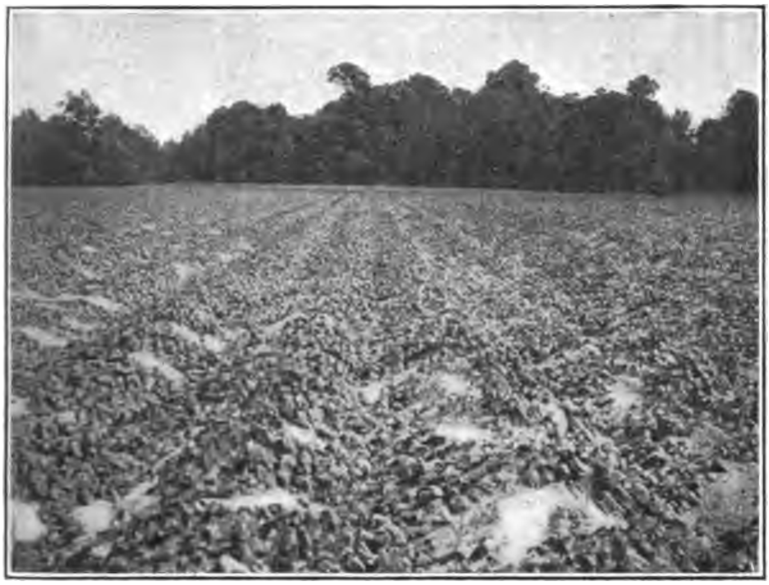

FIG. 14.—A field of sweet potatoes after the vines have practically covered the ground.

When the vines begin to interfere with further cultivation the crop may be " laid by," i. e., given a final working in which the soil is drawn well up over the ridges and the vines then allowed to take full possession of the land, as shown in figure 14. To do this it is often necessary to turn the vines first to one side of the row and then to the other by means of a stick or a wooden rake. After " laying by," very little attention is required until time for harvesting the crop.

TOOLS ADAPTED TO SWEET POTATO CULTIVATION.

Aside from planting and harvesting, the work of caring for a crop of sweet potatoes can be done almost entirely by the use of ordinary farm and garden tools. A two-horse riding cultivator is desirable for the general cultivation, and one having disks instead of hoes will serve for throwing the soil toward the rows. For the work of " laying by," a single-row celery hiller is suitable, or a one-horse sweep-stock can be fitted with sloping boards and used for this pur as shown in figure 15. Many growers use a small one-horse t

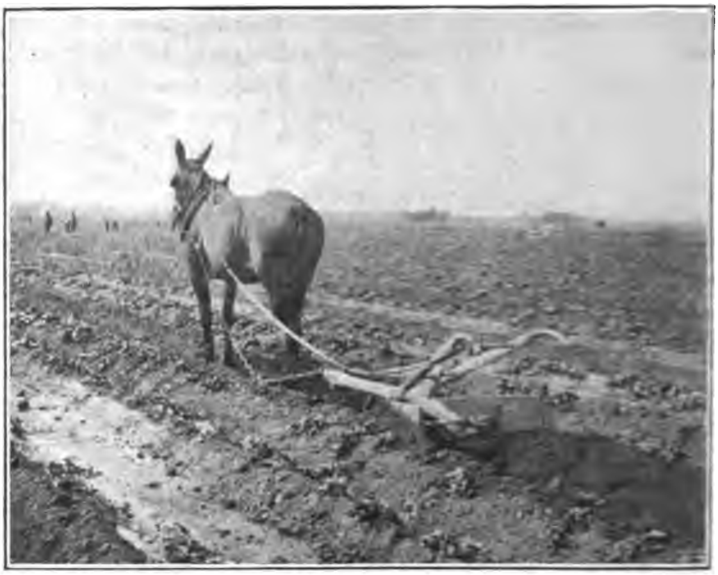

Fig. 15.—Device for hilling previous to "laying by."

plow for the final cultivation, going twice in each alley and work the soil toward the plants.

DISEASES.

The sweet potato is subject to injury from a number of dise Those diseases causing rot and decay are most prevalent and r in the greatest loss during the period that the crop is held in stora Occasionally, however, the crop may be lost before harvesting. one form of rot, known as black-rot, destroys the young plants tacks the potatoes while they are in the ground, and causes them decay while in storage. The spores that are responsible for several forms of rot affecting sweet potatoes may remain in the from year to year, or they may be carried over winter upon the Diseases are generally introduced with affected seed or plants when once established in the soil, the storehouse, or the propagat bed it is doubtful whether they can be eradicated except by the ad tion of the most thorough methods.

BLACK-ROT OF THE SWEET POTATO.

As the black-rot (*Ceratocystis fimbriata*) is widely distribu and destructive, it is perhaps the only disease that will cause gr difficulty. The black-rot may be easily detected upon the yo lants either in the form of a blackened and shriveled condition of he terminal buds or as small black spots on the main portion of he root. On the potatoes this disease first appears as brown patches pon the surface. These patches are generally quite irregular in utline and spread rapidly until the entire urface is covered. As the patches enlarge, he central portion becomes darker, often lmost black. The presence of black-rot pon the potatoes can usually be detected t digging time, or more certainly when electing the seed for bedding in the spring. ome idea of the appearance of this disease an be gained from figure 16.

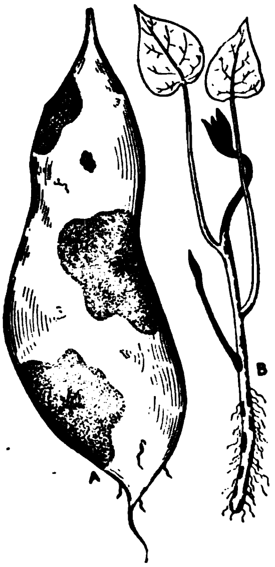

Fig. 16.—Sweet potato affected with black-rot: A, appearance of disease on potato; B, plant affected with black-rot. (Redrawn from Halstead, Bulletin 76, New Jersey Agricultural Experiment Station.)

THER DISEASES OF THE SWEET POTATO.

A disease known as stem-rot causes the tem of the plant to begin to die at the surace of the ground. This decay gradually xtends downward to the potatoes and freuently kills the entire plant.

The diseases known as soft-rot, dry-rot, nd white-rot are all similar in their method f attack to the black-rot. One form, known s soil-rot, causes the loss of the crop while t is in the field. Each of these diseases is aused by a particular fungus, but has reeived the common name suggested by its eneral appearance or some marked characeristic. Any one of the diseases of the weet potato may be present without causing evere loss provided conditions are unfavorable to its development, nd growers should be constantly on their guard to prevent the pread and development of diseases.

PREVENTION AND CONTROL OF SWEET POTATO DISEASES.

The diseases of the sweet potato have been under observation for nany years, the New Jersey Agricultural Experiment Station having ublished a bulletin[a] upon the subject in 1890, and this work has een supplemented by the results gained by numerous observers. The liseases of the sweet potato are now widely disseminated, and one or nore of them may at any time prove destructive.

A system of crop rotation by which the land will not be planted to weet potatoes oftener than every four or five years is the first step toward disease control. Care in the selection and keeping of potatoes intended for propagation is of importance, while clean cultivation and proper handling at the time of harvesting are essential. Diseases will generally make their first appearance upon cut, broken, or bruised potatoes, and all that are in any respect injured should be stored separately from the seed and perfect stock. The storage house should be cleaned and fumigated with sulphur or formalin before storing begins, and all crates or baskets used for handling the crop should be in the house during the fumigation. Potatoes that show evidence of the presence of disease should not be used for propagation, and the hotbed should be cleaned and supplied with fresh soil each season.

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[a] Bulletin 76, New Jersey Agricultural Experiment Station, by Halstead.

It is very apparent that some varieties are more subject to the attacks of diseases than others. The Big-Stem Jersey and the Jersey group generally are especially subject to disease, while varieties of the Hayman group, such as Southern Queen, are seldom affected.

INSECTS.

The sweet potato is reasonably free from the ravages of insects. Cutworms frequently destroy the young plants after they are set in the field, especially when the land has been in grass the previous season. The sweet-potato borer, which works in the roots, is widely distributed and causes considerable injury in the Gulf Coast States. A small insect known as thrips works on the under side of the leaves during the hot and dry weather of midsummer, but as a rule the real damage caused by this insect is slight.

HARVESTING SWEET POTATOES.

TIME FOR DIGGING SWEET POTATOES.

The harvesting and marketing of sweet potatoes direct from the field begins about the middle of August and continues until the crop is all disposed of or placed in storage for winter marketing. During the early part of the harvesting season the yield is light, but as a rule the prices paid are good. The supply for home use and those potatoes that are to be kept in storage should not be dug until just before frost. In the localities where frosts do not occur until quite late in the season the sweet potatoes ripen and the vines show a slight tinge of yellow when ready for handling.

EFFECT OF FROST ON SWEET POTATOES.

The foliage of the sweet potato is very tender and is easily injured by frost. A light frosting of the leaves will do no harm, but should the vines become frozen before digging they should be cut away to prevent the frozen sap passing down to the roots and injuring them. Where there is a heavy yield of potatoes the soil is frequently cracked or the ends of the potatoes protrude above ground and are liable to injury from severe frost.

If on account or rainy weather or for any other cause the potatoes can not be dug before frost or immediately afterwards, the vines should be cut away and the potatoes removed at the first opportunity. If cold weather continues it may be necessary to draw a little extra soil over the hills to protect the potatoes, or the vines may be piled in a ridge over the row. A very slight frosting of the potatoes will cause them to decay within a short time after being placed in storage.

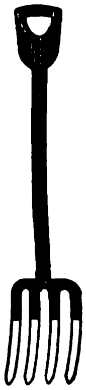


FIG. 17.—Spading fork adapted for digging sweet potatoes.

METHODS OF HARVESTING SWEET POTATOES.

For digging a small area of sweet potatoes, the spading or potato fork illustrated in figure 17 is suitable. When digging by hand, the work will be greatly facilitated by first throwing a small furrow from one side of the row by means of a one-horse turning plow. The removal of sweet potatoes from the soil in large quantities is generally accomplished by the aid of sweet potato diggers or plows of the type shown in figure 18. These implements are provided with two sharp rolling coulters that cut the vines ahead of the plow, and differ from the ordinary plow in having a moldboard that does not turn a furrow and terminates in a number of rods or an extension of the moldboard for separating the potatoes from the soil.

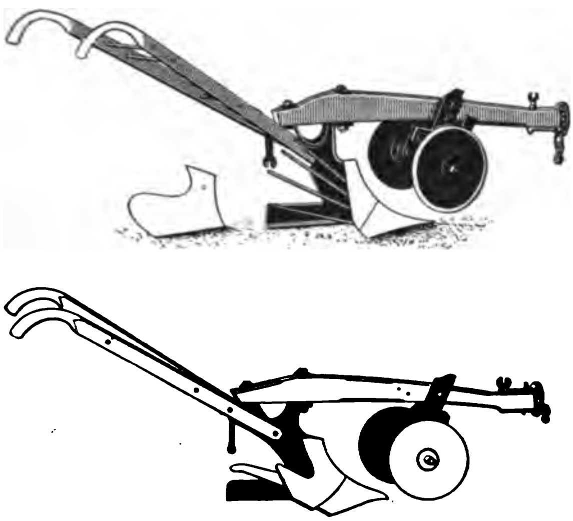


FIG. 18.—Special plows for digging sweet potatoes.

Where no special digging device is available, the ordinary two-horse turning plow is frequently used, a rolling coulter being attached to the beam to cut the vines. After plowing out the sweet potatoes it will be necessary to stir the soil in order to find those that become covered. The machines employed for handling Irish potatoes may be used for digging sweet potatoes, but are not entirely satisfactory for this purpose, as they bruise and otherwise injure sweet potatoes.

It is desirable that the soil should be comparatively dry at the time of harvesting sweet potatoes, and bright, drying weather is essential to the proper handling of the crop. Sweet potatoes differ from Irish potatoes in that they are not so easily injured by sunlight. However, they should not be exposed for any length of time if the sunshine is very warm. During the handling in the field it should be the purpose to remove all soil and surface moisture from the potatoes. Sweet potatoes should not lie exposed upon the surface of the ground during the night.

MARKETING DIRECT FROM THE FIELD.

Where sweet potatoes are grown in large quantities for early marketing it is the practice to dig, pack, and load, all on the same day, direct from the field. As the potatoes are gathered up behind the diggers they are sorted into the various grades and packed in ventilated barrels ready for shipment. When the barrels are packed in the field they are as a rule covered with burlap or similar material. In parts of New Jersey the potatoes are sorted in the field and gathered into five-eighths-bushel baskets, in which they are hauled to the depot platform, where they are packed into barrels and headed. More than one-half of the commercial crop is marketed direct from the field without the use of packing sheds or storage of any kind other than that provided by the transportation companies.

GRADING AND PACKING.

In sorting sweet potatoes preparatory to packing, about four grades are recognized, as fancy, primes, seconds, and culls. Those packed as fancy include only the most select, both in size and shape. The primes include all those adapted to general first-class trade, while the seconds include the smaller and more irregular stock which goes to a lower priced trade. The culls are not marketed unless good stock is exceedingly scarce, and as a rule are used for feeding to hogs.

Sweet potatoes are usually shipped in barrels holding eleven pecks each. Some markets require that the barrels be faced and headed, while for others the tops are slightly rounded and covered with burlap. Small lots of extra-fancy sweet potatoes are sometimes shipped in one-bushel crates having raised tops; also in patent folding crates.

Throughout the process of handling care must be exercised to see that the sweet potatoes do not become bruised, for upon this the shipping and keeping qualities greatly depend.

STORAGE OF SWEET POTATOES.

METHODS OF STORING.

Unlike most perishable products, the sweet potato requires warmth nd a dry atmosphere while in storage. The method of storing will epend both upon the locality and the quantity of potatoes to be cared or. The temperature and conditions of a rather cool living room re admirably adapted for keeping sweet potatoes intended for home ise in the North, while in the South they may be placed in pits or tored in outdoor cellars. The home supply may be placed in crates nd stored in a loft over the kitchen part of the dwelling. Sweet otatoes should not be stored in bags or in barrels without ventilation.

PITS AND CELLARS.

Where large quantities of sweet potatoes are stored for winter marketing, the method employed in the Southern States is to place them n outdoor pits and cellars, while at the North some form of heated torage house will be required. Whether the storage be in pit, cellar, r house, a dry, warm atmosphere with ventilation is essential to good eeping.

Storage pits should be located where the drainage is good. First, a little of the surface soil is thrown back to form a level bed 8 or 10 feet in diameter; then two small trenches crossing each other at right angles in the center of the bed are excavated and some boards laid over these. At the point where the trenches cross, a loosely nailed 4 by 4 inch box is set on end to form a flue up through the potatoes. The earth floor of the pit should be covered with 2 or 3 inches of hay, leaves, or pine straw, and the potatoes piled in a large, conical heap around the ventilator flue. When the heap is of the desired size, the potatoes are covered with hay or pine straw, and soil to the thickness of 5 or 6 inches is added, but the trenches and flue are kept open until it is necessary to close them to keep out the frost. In the South sweet potatoes are frequently kept throughout the winter by this method. A cross section of this type of pit is shown in figure 19.

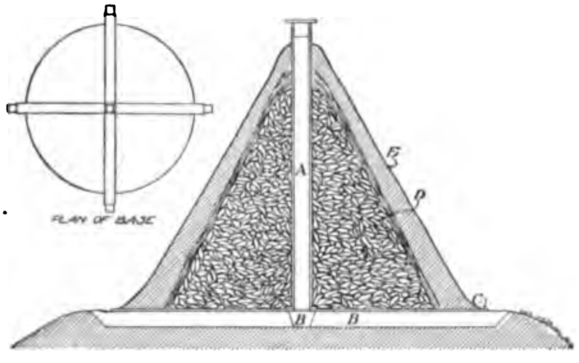


FIG. 19.—Section of outdoor pit: A, wood box for air shaft; B, trenches for admission of air; C, board covering trench; D, straw or pine needles; E, soil.

OUTDOOR CELLARS.

The type of storage cellar illustrated in figure 20 is extensively used throughout the South. This form of cellar is built entirely above ground and consists of a line of posts through the center supporting a ridgepole upon which is placed one end of planks or puncheons with their opposite end resting on the ground on either side of the ridge. The ends of the inclosure are boarded up, a door being provided in one, and the structure covered with sod to a thickness of 5 or 6 inches. The sweet potatoes are stored upon the earth floor and the door is kept open for a time for ventilation. If the house exceeds a length of 12 or 14 feet, a top ventilator should be provided.

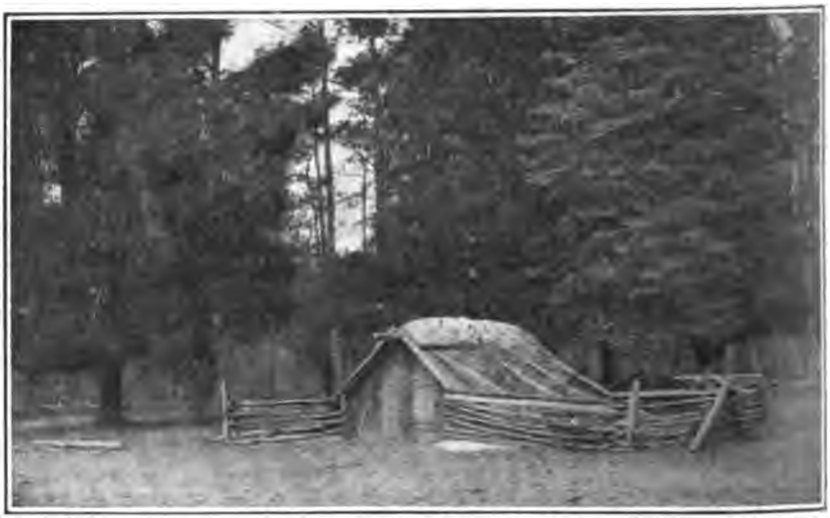


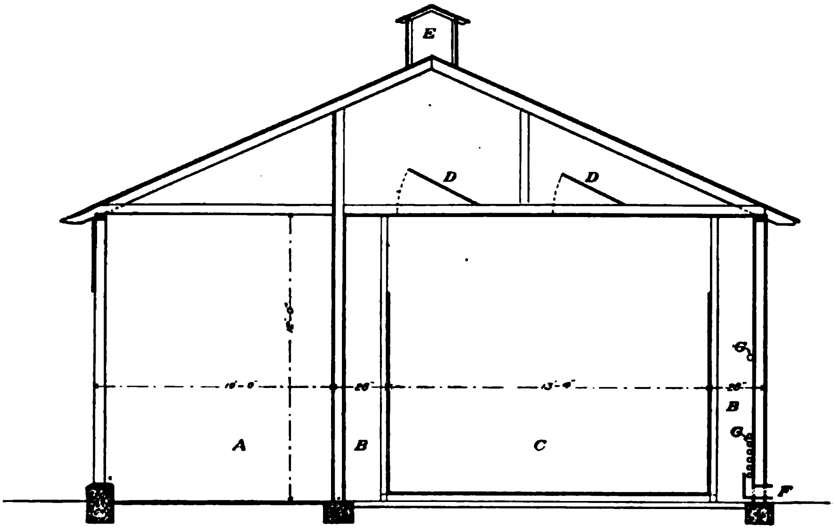
FIG. 20.—Outside cellar. Such cellars are extensively used throughout the Southern States for the storage of root crops.

STORAGE HOUSES.

In the North, where the winters are too severe for the use of the pit and the outdoor cellar, some form of regular storage house is employed. These houses are constructed with frost-proof air-space walls, and provision is made for heating during the curing period and severely cold weather.

The usual method of constructing storage houses is to first put down a concrete foundation, upon which a frame of 2 by 4 inch and 2 by 6 inch scantling is reared. On the outside a sheathing of 1-inch lumber is nailed, preferably diagonally, to add strength to the building. Over this sheathing heavy building paper is applied and a covering of " drop " or " lap " siding put on. The roof may be of tin or shingles, or one of the better grades of prepared paper roof-ıg will answer. Inside the building, paper is first tacked to the udding, and then one thickness of ⅞-inch matched lumber is nailed ı. The ceiling may be carried upon the rafters or squarely across, ith several openings into the space above for ventilation. Where ıe ceiling is attached to the rafters, it is desirable to first nail 1-inch rips to the rafters and then run the matched ceiling up and down, ı order that any condensed moisture will follow down the grooves › the sides of the house rather than drop upon the potatoes.

The floor may consist of boards, concrete, or hard clay. The bins ›r holding the potatoes may be constructed of 2 by 4 inch scantngs and 1 by 4 inch strips, a convenient size of bin being about) feet in length by 12 feet in width and 10 feet deep. The bins hould be built 14 to 18 inches away from the outside walls and a -inch space should be allowed between the bins. A floor of narrow ›oards raised a few inches above the regular floor will provide for a 'ree circulation of air through the potatoes. The size and number ›f bins will depend entirely upon the quantity of potatoes to be tored. For each 100 bushels of potatoes to be stored a space of 25 cubic feet will be required. A bin of the dimensions given ıbove, if filled to a depth of 8 feet, will hold about 1,500 bushels of ›weet potatoes.



ıG. 21.—Cross section of large storage house: A, driving shed; B, space between outer walls and potato bins; C, storage bins; D, ceiling ventilators; E, top ventilator; F, bottom ventilator; G, heater pipes.

Brick or concrete storage houses are desirable, but require to be ined with wood in order to be dry and warm. The greater number ›f storage houses in use are of frame construction, and any building which is dry, which can be properly ventilated, and in which the proper temperature can be maintained will be found suitable for sto sweet potatoes. If a house is built expressly for the purpose possible to provide many convenient features, including heating pliances and loading and unloading platforms, and a covered dr way along one side is desirable. Very few windows are re in the storage house, and these should be provided with tight ters to keep out light and cold. A cross section of the type of age house in general use is shown in figure 21.

STORING THE CROP.

In housing the crop the potatoes are hauled to the house in eighths-bushel baskets or in bushel crates and spread upon tables for sorting.

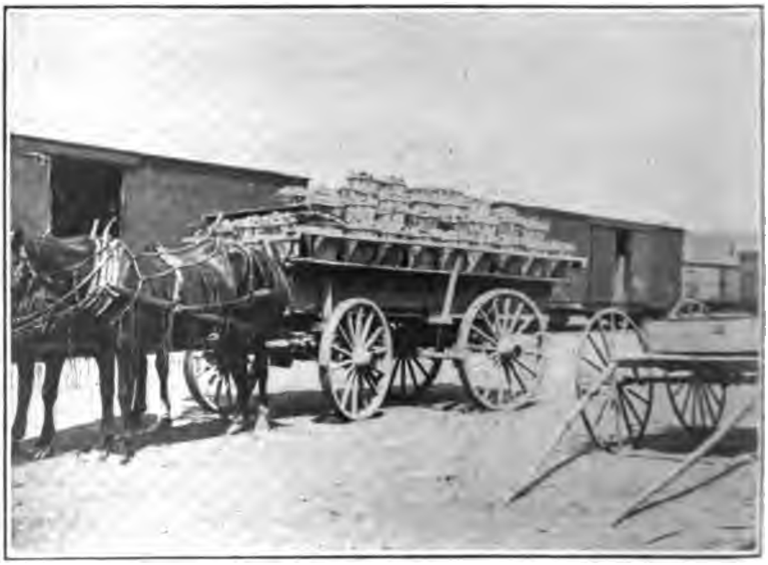


FIG. 22.—Wagon and baskets adapted for transporting sweet potatoes from the storage house or shipping point.

Where large quantities of sweet potatoes are to be handled fr the field to the storehouse or shipping point, it is desirable to em wagons specially fitted for the purpose. If the road is at all r the wagons should be provided with bolster springs to lessen jolting of the potatoes. A wagon for this purpose should have ra low broad-tire wheels and a shallow box or framework fitted for h ing the baskets or crates. The wagon shown in figure 22 is the used by the growers of New Jersey and is well adapted to the dling of a large number of baskets. For hauling barrels an nary hay rack is desirable. The ordinary wagon box, or bed, is adapted to the handling of either baskets, crates, or barrels.

The seed stock for planting the following year should be selected and stored separately in a small bin. As the potatoes are separated into their respective grades they are put into baskets and carried to the bins.

Some growers prefer to do the grading in the field, but this necessitates the employment of a larger percentage of expert labor and delays the work of getting the potatoes hauled to the storehouse. Women and children can pick up the potatoes in the field, and two or three experienced men can do the sorting and grading at the house in a much shorter time and in a more satisfactory manner.

The most desirable form of table upon which to spread sweet potatoes for sorting consists of a wooden framework over which strong burlap or canvas is stretched. This forms a hollow surface from which the potatoes will not roll or become bruised in handling. The sorting tables should be placed alongside of the unloading platform and where the distance to the storage bins is short. If a shed is provided at the side of the storehouse, the sorting tables should be along the side nearest the bins, the wagons being driven on the outside and the baskets of potatoes to be sorted unloaded under the shed.

Before starting to fill a bin, 2 or 3 inches of dry pine needles, straw, or chaff should be placed upon the floor. Beginning at the back of the bin the potatoes are piled to a depth of 30 or 40 inches until the entire floor space is covered and a number of slats are required to be placed across the doorway opening. A few grain bags filled with straw should be placed upon the potatoes at intervals from front to back of the bin, and upon these planks on which the men may walk while carrying in the next layer of potatoes may be laid. In this way a bin may be filled to a depth of 8 or 9 feet by about three layers. By dumping them in layers the potatoes have an opportunity to become thoroughly dry before a new layer is placed over them.

TEMPERATURE AND VENTILATION OF STORAGE HOUSES.

Two or three days before beginning to bring in the potatoes, the torage house should be thoroughly cleaned and the heating appliance ut in working order and started, in order to have the house both arm and dry when the crop comes in. Throughout the time of storng and for about ten days after the potatoes are all in the bins a mperature of 85° or 90° F. should be maintained in the house, with lenty of ventilation. This constitutes what is known as the sweatng or curing process, and the keeping qualities of the potatoes deend upon the thoroughness with which this part of the work is done. ood-burning stoves are frequently employed for heating sweet poto storage houses, but a hot-water boiler with coils of pipes along e walls of the building is very satisfactory.

After the crop is all in and thoroughly cured, the temperatur the storage house should be gradually lowered and may vary betw 55° and 65° F., but considerable ventilation should be maintain

Sweet potatoes should be handled very carefully and as few ti as possible, the essentials to good keeping being a reasonable de of warmth, a dry atmosphere, and careful handling. Great should be taken with the seed for the next year's planting to se it is carefully handled and properly stored.

While a temperature of 80° or 85° F. is required to properly s the seed into growth in the spring, a higher temperature duri long period of time in storage is liable to injure or even kill the Potatoes intended for seed should not be stored in too great quanti and where but a small supply is needed they can often be kept bu in dry sand after having first been thoroughly cured. The sand for this purpose should be baked to insure the driving off of mo ture, and may be placed around the potatoes while slightly warm

In controlling the ventilation of the storage house during winter months, outside air should be admitted only when quite and when its temperature is lower than that of the air in the stor house. If warm, moist air is admitted considerable moisture be deposited upon the potatoes, thus injuring their keeping qual

LOSS FROM SHRINKAGE WHILE IN STORAGE.

Under proper storage conditions sweet potatoes will shrink fro to 10 per cent, but the loss in weight will be greater if the temper ture of the house is carried too high. If the potatoes are not ma when dug from the field the loss from shrinkage may be as much 15 per cent, and immature stock should be marketed early in winter.

MARKETING DURING WINTER MONTHS.

For marketing from outside pits it is desirable to have the q tity stored in one pit small enough to permit of all being remov one time. The potatoes may be removed from outdoor cellars desired. In marketing from heated storage houses the potato should not be disturbed until they are barreled or crated, and they should be placed directly upon the market and sold with delay.

When shipping during cold weather the barrels should at lea lined with paper, and a covering of heavy brown paper over the side of the barrels will form a safeguard. If the potatoes are sh in carload lots during the winter the cars should be either of regular refrigerator type or felt lined, and in some cases a s hould be provided. When once placed upon the market the potatoes hould reach the consumer within a comparatively short time.

Figure 23 shows the type of barrel employed; also the method of ressing the heads nto place.

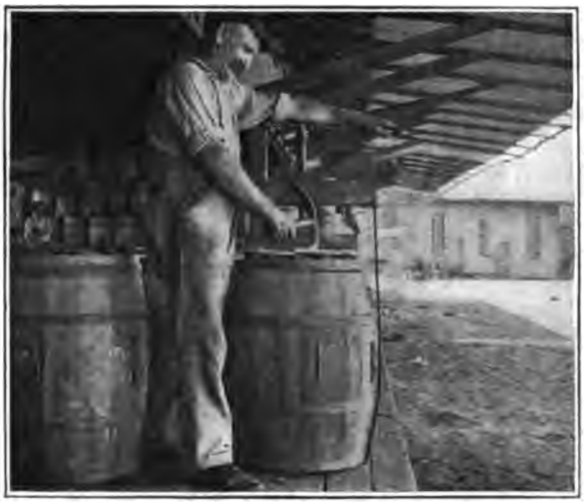


FIG. 23.—Sweet potato barrels and device for pressing the heads into place.

ARIETIES OF SWEET POTATOES.

Of the large umber of varieies of the sweet otato there are not nore than ten that re now of great ommercial imporance in the United tates. For the narkets that reuire a dry, mealyleshed potato those arieties belonging to the Jersey group are suitable. For the southrn trade and where a moist-fleshed potato is desired those comnonly designated as yams are in demand. Among the Jerseys that re extensively grown are the Big-Stem Jersey, the Yellow Jerey, and the Red Jersey. The principal varieties of the yam group re the Southern Queen, the Pumpkin Yam, the Georgia, the Florida, nd the Red Bermuda. Of the varieties mentioned there are a large umber of special strains, known under many local names.

In the selection of varieties for home use one must be governed argely by locality. As a rule those of the Jersey group will thrive arther north than those of the so-called yam types. For market urposes the particular variety or strain grown in the vicinity should irst be selected, and afterward other varieties may be experimented vith in a small way.

The following brief descriptions of a few of the leading varieties nay be of assistance in selecting those best adapted to various condiions of soil and climate:

Big-Stem Jersey.—This variety (fig. 24, C) is the most popular mong growers who are supplying the northern and eastern markets. It is a form of the Yellow Jersey, having been selected for its proluctiveness and dry, yellow flesh. The vines are slender and long; he potatoes are of spindle shape and inclined to grow rather large;

color of potatoes yellow; color of flesh light yellow or deep cr While this variety yields heavily, it is unfortunately a rather p keeper, and its flesh is inclined to become dry and "punky" tow spring. It will thrive well toward the north, but is better adap for use as a commercial variety than for home consumption.

Yellow Jersey.—The vines of the Yellow Jersey variety are l and more slender than those of the Big-Stem Jersey, and the pot are of spindle shape, but much smaller; otherwise the two vari are very similar in appearance. The flesh is dry and mealy. T variety is a fairly good keeper and retains its quality well. It adapted for home use and thrives under a wide range of conditi but does not yield heavily enough for commercial purposes.

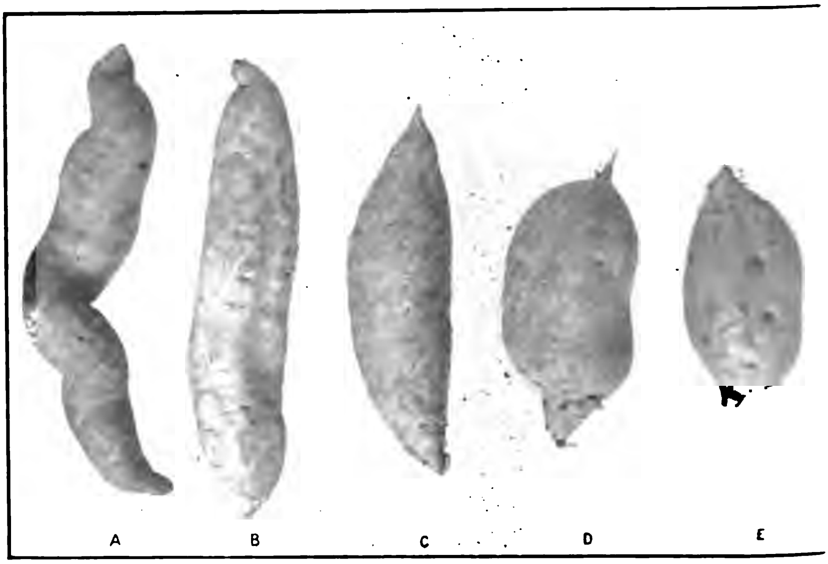


FIG. 24.—Some of the commercial types of sweet potatoes: A, Black Spanish, or ger Choker"; B, Long, cylindrical type; C, Jersey group, spindle shape; D Bermuda; E, Southern Queen.

Red Jersey.—This is similar to the Yellow Jersey variety, ex that the roots are red and it is more productive under most c tions. It is suitable for home use.

Southern Queen, or Hayman.—The vines of this variety are str and vigorous; the potatoes are large, thick, and blunt at ends or short spindle shape; the color is white or light cream, while the f is of cream color, becoming darkened in cooking, moist, and v sweet. This variety is most extensively grown for market purpo where a sweet, moist-fleshed potato is demanded. The South Queen yields well, is an excellent keeper, and is adapted for b marketing and stock feeding and for home use in the South Atlantic and Gulf Coast States, but it does not mature when grown in the extreme North. (See fig. 24, E.)

Pumpkin Yam.—The vines are vigorous, short, sometimes of a bunch habit. The potatoes are of short spindle shape or quite round, with a dull yellow color on the outside. The flesh is orange or sometimes yellow and marbled with orange; it is moist and has a flavor very similar to that of good squash. This variety yields well and is adapted to home use and to stock feeding throughout the South.

Georgia, or Split-Leaf, Yam.—The vines of this variety are slender and long; the potatoes of medium size, spindle shape, yellow; the flesh a light yellow, marbled with salmon. The quality of this variety is excellent and very sweet, but it is a light yielder. It is a splendid sort for home use throughout the South Atlantic and Gulf Coast States.

Red Bermuda.—The Red Bermuda vines are large and vigorous. The potatoes are usually large and overgrown with heavy ridges and veins. The color of the potatoes is rose red; flesh, creamy; quality fair but not so sweet as Southern Queen. This variety is a heavy cropper and suitable for feeding to stock. It is one of the few so-called yams which thrive in the northern portion of the sweet potato area. (See fig. 24, D.)

Florida.—The vines of the Florida variety are large and vigorous. The potatoes are rather large, light salmon yellow, smooth and regular, of short spindle shape, with light yellow flesh. This variety is not so sweet as the Georgia and is inclined to be dry and mealy. It yields fairly well and is adapted for home use.

Pierson.—The vines of the Pierson are similar to those of the Red Bermuda variety. The potatoes are light yellow, of short spindle shape, very rough, with cream-colored flesh. This sort is extensively grown for the earliest market, but it is of only fair quality. It yields well if allowed to remain until late in the season.

Black Spanish, or "Nigger Choker."—The Black Spanish vines are very long, vigorous, and dark purple in color. The potatoes are long, cylindrical, crooked, or bent; dark purple in color, with snowy white flesh and poor quality. This variety is grown mostly for stock feeding. (See fig. 24, A.)

Shanghai.—The vines of the Shanghai variety are large and vigorous; the potatoes long, cylindrical; the outside color almost white. The flesh is creamy white, becoming darker in cooking. When baked the flesh is somewhat dry and mealy and the flavor rather poor. This variety yields fairly well and is adapted for use as stock food in the Gulf Coast States. (See fig. 24, B.)

COST OF PRODUCTION AND RETURNS.

The cost of growing an acre of sweet potatoes will vary with cropping plan and the extent to which the crop is grown. On average the cost of growing an acre of sweet potatoes in the reg commercial district is about as follows: Rental of land, $8; plo and fitting, $5; fertilizers, $20; 10,000 plants, $10; planting cultivating, $5; digging and marketing, $25; total, $78. An aver yield of sweet potatoes is at the rate of one barrel to 100 hills or barrels to an acre. The price per barrel paid the grower is less than $1.25, and $2.50 or $3 is not uncommon. During seasons the net profit from one acre of sweet potatoes is about While occasionally the net returns are from $100 to $150 an acr a single season, there are seasons of crop failure or overprodu when very little, if any, profit is realized.

The sweet-potato growers on the eastern shore of Virginia as a plant about 10 acres in sweet potatoes, and this constitutes money crop. The remainder of the cleared portion of their farms is devoted to corn, pasture, and hay, all for home use. the sweet-potato crop is grown almost entirely without the ai hired help, and the cost of production does not exceed $40 an a Where the crop is stored the gross returns are greater, but the of production is increased proportionately.

USES OF SWEET POTATOES.

The uses of the sweet potato as a table vegetable are too import and too well known to require more than brief mention in a publi tion of this character. In preparing them for the table they baked, boiled, fried, or braised, while for pies they are used in same manner as pumpkins.

A number of attempts have been made to build up an industry the production and sale of desiccated sweet potatoes and sweet-p flour. There is doubtless a great field for this class of goods, cially for export and for ship supplies.

USES FOR STOCK FOOD.

The vines of the sweet potato when properly cured make a m grade of hay for feeding to cattle and sheep. In the green state vines are eaten by sheep, cattle, and hogs, but their feeding val comparatively small. The potatoes are fairly well adapted to f ing to range cattle, sheep, and hogs, although their nutritive is quite low and they require the addition of cotton-seed meal or to make a balanced ration. On farms where sweet potatoes grown extensively the culls are fed to hogs, together with a one-th or one-half ration of corn.

By employing one of the heavy-yielding varieties of sweet potatoes, such as the Southern Queen or the Bermuda Red, and drying and pulverizing them, a splendid stock food may be produced, especially when sufficient grain is added to form a balanced ration.

The principal uses of sweet potatoes are, however, for the table, and the demand for this purpose is rapidly increasing.

From the fact that by the aid of commercial fertilizer alone sweet potatoes can be grown on comparatively poor land and largely by the use of labor-saving machinery, this crop may in a great measure solve the problem of how to occupy the "worn-out" cotton and tobacco lands of the South, especially if employed in a rotation including corn, peanuts, and grass. By the perfection of some means by which sweet potatoes could be dried and converted into a condensed stock food on the farm, they in conjunction with corn, peanuts, and a little hay would serve to keep the stock on southern farms in good condition during the winter.

When removed from the ground the sweet potato contains about 71 per cent of water, 1.5 per cent of protein, 25 per cent of nitrogen-free extract, and 0.35 per cent of fat. It will be noted that both the protein and fat content of the sweet potato are comparatively low. The analysis of peanuts shows that the protein and fat are both quite high, and by combining them with sweet potatoes at the rate of one bushel of peanuts, ground in the shells, to three bushels of sweet potatoes a splendid stock food is produced. Three bushels of sweet potatoes are nearly equal to one bushel of corn in feeding value, but in order to make them satisfactory as a stock food it is necessary to add peanuts, cotton-seed meal, or grain.

USE FOR PRODUCTION OF ALCOHOL.

The starch and sugar content of sweet potatoes varies considerably in different varieties, but as a rule they contain about 16 per cent of starch and 4 per cent of sugar, making a total of 20 per cent of alcohol-producing material. It is possible that sweet potatoes will become one of the chief sources of denatured alcohol in the United States, but at present the methods of manufacture have not been sufficiently perfected to warrant their use for this purpose on a farm or community basis.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 325.

SMALL FARMS IN THE CORN BELT.

BY

J. A. WARREN,
Scientific Assistant, Farm Management Investigations,
Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 4, 19

Sir: I have the honor to transmit herewith a paper entitled "S
Farms in the Corn Belt," by J. A. Warren, Scientific Assistant,
pared under the direction of the Agriculturist in Charge of F
Management Investigations, and recommend that it be publish
a Farmers' Bulletin.

In this bulletin an effort has been made to show some of the se
difficulties that confront a farmer of moderate means, to give
of the reasons for the alarming rapidity with which young men a
flocking to the cities, and to show by actual records how some h
solved the problems which all are facing.

Each of the farms here described has been visited in at least t
different years and all the data have been obtained from the own
and are believed to be perfectly reliable. A number of such far
representing several other States which would have served as w
for illustration have been studied, but the records were too meag
to show what had been done.

The conditions here considered are much the same over most
the corn belt. The points brought out in the discussion are the re
of several years of study along these lines and many years
experience in that region.

Respectfully,
B. T. Galloway,
Chief of Bure

Hon. James Wilson,
Secretary of Agriculture.

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Fig. 1. Diagram of the Beadle farm as it appeared in 1907
2. Diagram of the Beadle farm showing suggested improvements in arrangement
3. Rows of crops in the pear orchard on the Martin farm

SMALL FARMS IN THE CORN BELT.

INTRODUCTION.

In the great corn belt, or at least that portion of it comprised in Indiana, Illinois, Iowa, northern Missouri, eastern Kansas, eastern Nebraska, southeastern South Dakota, and southern Minnesota, the majority of the farms contain 160 to 320 acres. Farms of only 80 acres are comparatively scarce, and not many farmers consider less than 160 acres sufficient to furnish a respectable living. Yet no careful observer can travel this region without being convinced that many a man would have a larger net profit and an easier and happier life if he farmed less extensively and more intensively. Good farms in this section are worth $50 to $200 an acre, or $8,000 to $32,000 for 160 acres. To this must be added $2,000 to $3,000 for teams, stock, machinery, feed, and seed, making a total investment of $10,000 to $35,000. How can the young man who has nothing to start on secure such a place? This is the problem that now confronts the majority of young farmers.

Ten to fifteen years ago many men with little or nothing to pay lown bought farms and have since paid for them, but they bought at fraction of the present prices. Take the moderate price of $75 an cre, or $12,000 for 160 acres, and add $2,000 for equipment, making total of $14,000. The interest on $14,000 at 5 per cent, which is the owest rate obtainable, amounts to $700 per annum. To expect to lear this each year after paying running expenses and a living and ave money left to pay on the principal requires more confidence an the average man possesses. Even if he takes the risk and wins, e chances are few that he will be able to pay his debts and have his me clear by the time he is old enough to need to be relieved from rd labor. If he is to remain on the farm, only two propositions main open to him. He can rent, with small chance of ever owning, farm or he can go elsewhere in search of cheaper land, neither of hich courses is very inviting. The large amount of money necessary r the purchase of a farm and the dim prospect of ever obtaining it scourage the farm boy, and as a result he begins, although reluctantly perhaps, to look for other employment, while the young who are not farmers see no opportunities for them in rural life

Farm wages seem small when compared with wages and sal offered for other work, but as a matter of fact they compare favorably when rightly considered. The farm boy, or even farmer of mature years, has little conception of the cost of living cities. In his experience most of the living has come from the and he has not realized that it cost anything. Thirty dollars a with board and washing is common wages for any good hand in of this region, and many can command more. A single man can as much out of $30 on the farm as out of $55 or $60 in the city. married man can usually secure $35 or $40 a month, a house, gar milk, fuel, a chance to keep poultry, and often feed for a pig. T is much more to him than $60 a month or $2.50 a day in town.

The hours required on the farm are not very much longer tha other occupations. The farmer is inclined to say he works hours a day if he rises at 5 o'clock and retires at 9, but in most after counting out meals and rest periods, it is found he has actually been at work more than eleven or twelve hours. In w the hours are nearly always much shorter, and at all times of year there are stormy days when little work is done. In town a working a team must work ten hours and take care of his team go to and from work outside of that, so his ten hours is of abou same length on the average as the farmer's sixteen. For the man works without a team the hours are not much shorter when the required in getting ready and going to work and in getting h again are considered, and if he is in one of the larger cities 10 a day must be expended for street car fare.

These unconsidered points, it seems to the writer, constitute main reasons for the increasing and deplorable migration of yo men from the farms to the cities, about which so much is being and written.

Can not the young man rent a farm or work for wages a few until he gets several hundred dollars ahead and then buy a tract—20 or 40 acres—upon which to make a comfortable home of own and have it free from incumbrance while there are still years of active life before him?

In this connection it may be interesting to see what is being on a few small farms. It is not presumed or even hoped that an will copy exactly any of the farms here discussed, and it is probable that failure would result if he did. The personal fac very important and no one should attempt to follow another's in every detail. Each man should follow the line in which he is likely to succeed and use all his own originality as well as adopt est practices of others. Then, again, varying conditions make one ype of farm most profitable in one locality and another type in nother locality, thus making a careful study of markets, soils, and limate indispensable. But there are hundreds of ways in which uccess may be attained on a small farm.

This bulletin aims to show how some practical men have solved he problem of securing homes on high-priced land, and if it suggests a way to others with limited means its purpose will be well erved. It is true that two of the men whose farms are here decribed secured their land at a low figure, but their results show that hey would have succeeded had they purchased high-priced land. No two of these farms are within 100 miles of each other—one is near town of 2,500 inhabitants, one is 7 miles from such a town, and one is 10 miles from a town of 8,000 people.

The discussion of farms near the larger cities has purposely been avoided, as has that of dairy farms, because (1) cities as a rule are far apart and there is room for comparatively few farmers near hem, (2) land is very high in the vicinity of cities, and (3) there s a mistaken idea that when located near a city the small farmer must be a market gardener or a dairyman, and there is a common prejudice against both of these types of farming.

All of the farms here described are found in a single State, but the conditions in all the States of the corn belt are so similar that if the localities were not mentioned no one could tell in which State they were to be found. Every statement applies with equal force to nearly all the region mentioned.

A FORTY-ACRE FARM IN SAUNDERS COUNTY, NEBRASKA.

DESCRIPTION.

Mr. C. E. Beadle owns and operates 40 acres of gently rolling upland prairie, much of it nearly level, in Saunders County, east-central Nebraska. The soil is a deep, dark silt loam characteristic of that region. The house, which is worth about $2,000, stands near the highway and is surrounded by a well-kept lawn bountifully supplied with trees and ornamental shrubbery. The farm buildings are not of special interest, because they were mostly on the farm when the present owner purchased it and are not such as he would have built.

In figure 1 is shown a diagram of this farm as it appeared in 1907.

CROPPING SYSTEM.

The cropping system followed is very simple, consisting of potatoes two or three years and mixed hay two or three years. In 1906 there were 14 acres in potatoes, 7 acres in hay, 11 acres in pasture, 1½ acres in sweet corn to supplement the pasture (but this was not neede 5½ acres in garden, orchard, and grounds, and 1 acre in a public ro In 1907 there were 7 acres of grass on the land that was in potat the previous year. Otherwise no changes were made. Hay eno for home use is produced, but all grain is purchased.

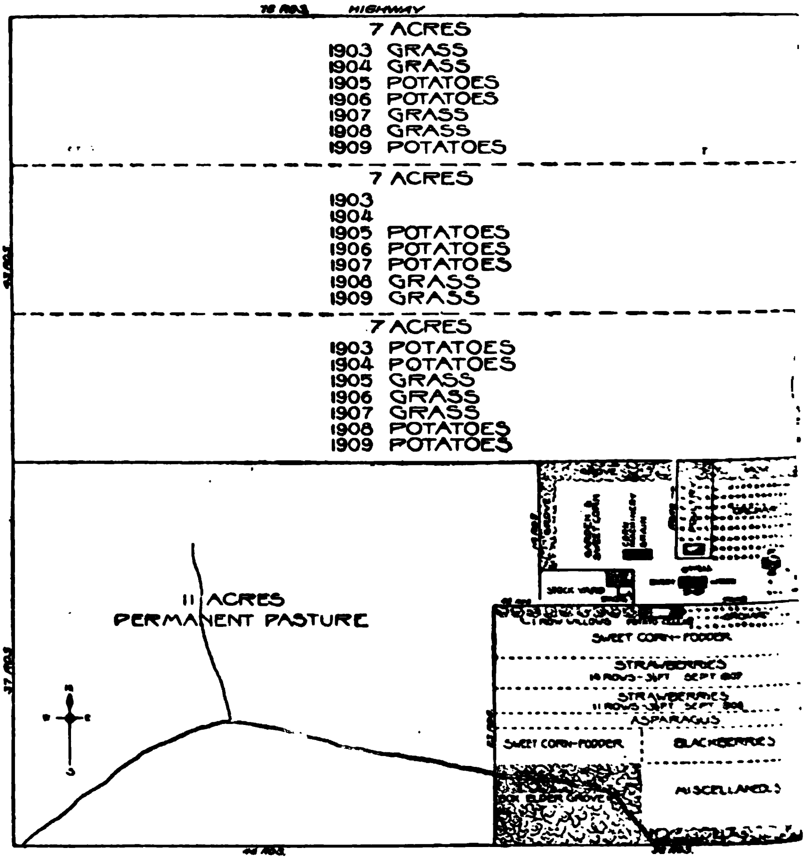

FIG. 1.—Diagram of the Beadle farm as it appeared in 1907.

POTATOES.

Seed Tubers.

Mr. Beadle plants nothing but northern seed potatoes and estim that these yield 50 bushels to the acre more than if seed only one ye removed from the North were used, while a better grade of potat is produced. Early Ohio and White Ohio are the varieties select the seed being grown at Fargo, N. Dak. The tubers are cut by ha to one or two eyes. Emphasis is placed upon the superior value the first sprout from an eye, as this sprout comes from the main central bud and is larger and stronger than the sprouts that come later. Then, too, in potatoes that have sprouted the plant food is unevenly distributed and many of the pieces from the stem end are worthless. For these reasons much care is taken to keep potatoes so they will not sprout till planting time.

Cultivation of Potatoes.

The clover and timothy meadow is plowed late in the fall and left till spring without harrowing. This late plowing exposes to the winter frosts many insects that might injure the potatoes. Leaving the ground unharrowed gives it a better chance to catch snow, and it also pulverizes better in the spring. The ground is disked before planting. The potatoes, after being cut to one or two eyes, are planted with a potato planter, 13 inches apart in the row and in rows 38 inches apart. This requires 10 to 12 bushels per acre.

Cultivation commences after the next rain. A four-shoveled cultivator is used, running very deep. Before the potatoes are up the ground is well harrowed, and as soon as they are up the cultivator is again used. The shovels are set to throw the dirt in and run deep, thus burying all the little plants. When the potatoes come through again the spring-toothed weeder is used both ways, leveling the ground nicely. The soil now has been stirred nearly as deep as plowed, is well pulverized, and is in excellent shape for root growth, to absorb water, and to withstand drought. It is perfectly free from weeds, for none can endure such treatment. From this time on the cultivator and the weeder are used alternately, the cultivator in these later cultivations having six 2½-inch shovels and running shallow so as not to disturb roots. The weeder is used until the plants are 10 or 12 inches high. The weeder is usually run crosswise and then lengthwise of the rows soon after each cultivation with the cultivator.

Potato Beetles.

As soon as any striped beetles, commonly called Colorado potato bugs, appear, boys are hired to gather them by the hundred. The price varies with the plentifulness of the insects, but is always high enough for the boys to make good wages, which are usually about 5 cents a hundred "bugs." The owner does not pretend to count the insects, but measures them in a can cover that holds 200. This is the cheapest and most effective way he has found for keeping the beetles in check. As this work is commenced early, very few young beetles are hatched. In 1905, 30,000 "bugs" were gathered from 14 acres at a cost of $15. In 1906, 35,000 were gathered from the same field. Sprays have never been used, but would doubtless prove profitable, as some damage is done by fungous diseases.

Digging Potatoes.

The digging gang consists of 1 man and 4 horses with the digg 2 teams and wagons, 4 men to pick up, and 2 men to sort and in the cave. This force puts in 600 bushels a day at a cost of 2¼ a bushel, not counting the men and teams on the digger.

Yield of Potatoes.

Two hundred bushels of potatoes to the acre are considered a crop, but 360 bushels have been produced. The yields are practi double the average of this part of the State. The increase is the high quality of seed, the thorough cultivation practiced, and rotation and manure used.

Cost of Producing Potatoes.

The estimated cost of producing an acre of potatoes and putt them in the cave is—

Plowing and harrowing	$1.50
Disking	.40
Seed, 12 bushels at 55 cents	6.60
Cutting and planting	1.50
Cultivating	4.00
"Bugging"	1.25
Gathering 200 bushels	6.50
Total	21.75

At these figures 1 bushel when stored in the cave has cost cents, without counting rent of land or use of machinery.

GRASS.

Nine pounds of timothy, 12 pounds of red clover, and 2 to 3 pou of alsike clover are sown to the acre, without any other crop ground that has grown potatoes two or three years. This is different from the common practice, which is to sow 8 to 10 pound timothy and 5 to 7 pounds of clover to the acre with a full cro wheat or oats. It will be seen that Mr. Beadle sows the usual q tity of timothy and more than double that of clover. He con heavy seeding and the full use of the land both essential to grass crops. The weeds are clipped once or twice, if necessary, hay crop is secured in the fall.

A hay crop the first year is almost an unheard-of thing in region. This man is able to produce it because of the good tion of his land and the fact that the grass has the full use of the A large proportion of the grass sown with grain fails to mak stand, but a failure has never occurred on this farm. The year two crops of hay are cut, and then there is usually a good af math to plow under or, if the grass is to stand another year, to leave for winter cover. No stock is ever allowed on the meadow. This is another important point. As a result of these practices the yields secured are more than twice those common in the neighborhood. In 1906, 52 loads, conservatively estimated at 1,500 pounds each, were produced on 7 acres, making a yield of over 5½ tons an acre for the season. The first crop in 1907 was 22 tons from the same field.

Hay is raked quite green and cured in the windrow and cock. As soon as sufficiently dry it is hauled to the barn. No salt or lime is ever used on the hay. A side-delivery rake has recently been purchased with the intention of using a loader on the windrows so as to save cocking and pitching.

PASTURE.

The pasture is permanent and consists of 11 acres of Kentucky bluegrass, timothy, and white clover. Throughout the season of 1906 it furnished plenty of feed for 5 cows and 5 calves, 3 yearling heifers, 1 horse, and the team when not in use. In July, 1907, there were 6 cows, 2 yearling heifers, 2 horses, 1 colt, and the team when not in use on this pasture, and still several tons of hay might well have been cut. In this locality tame pastures usually require 1½ to 2 acres for each head of stock, but it will be seen that this pasture is supporting about a head per acre besides the calves and colt, and there is feed to spare. The difference is due entirely to difference in care. Here manure is frequently applied, and weeds, such as thistles, dock, and ironweed, are either cut off or dug out. In this way a dense, luxuriant growth of grass is secured.

FRUIT.

While fruit growing is of minor interest on this farm, it adds considerably to the net income. Especially is this true of the half acre of strawberries, which returned $260 in 1907, and the quarter acre of blackberries, from which 375 quarts had been sold up to August 7, with one-third of the crop still on the bushes. Vegetables are rarely sold. These products are nearly all retailed at a good price, and special effort is made to deliver them in first-class condition.

MANURE.

Both meadow and pasture receive a heavy dressing of manure in the winter. No manure is used directly on the potatoes and no commercial fertilizer has ever been used. What is made in the summer is hauled directly to the pasture. During the winter the cattle yard, as well as the barn, is kept well bedded with wheat straw, so that as much manure as possible will be made. The straw is secured from the neighbors for almost nothing. What manure is needed is hauled from a near-by town, where it is to be had free of charge.

HORSES.

An old team and 1 young mare, 1 two-year-old colt, and 1 spr colt are now on the farm. The mare is a high-grade Percheron a the colts are always from the best available sire of that breed. Th are fed but little grain during the winter and none in the summ The work horses are never grained heavily and are pastured w not in use in the summer.

CATTLE.

All the cattle, except 1 milk cow which is kept for family use, ar registered Shorthorns of good quality. The calves, of course, are al lowed to run with the cows. A little corn is fed during the winter but none in the summer. The cattle business is not yet well esta lished, and unfortunately the young stock has not thus far sold at good prices as the owner could justly expect. The herd now conta 6 cows, 2 yearling heifers, and 1 bull, and 6 calves are expected th season.

POULTRY.

About 50 Barred Plymouth Rock hens are kept primarily for fam ily use, but most of the cockerels are easily sold at $1.50 each fo breeding purposes; also a few eggs for setting. The flock is ke confined during the summer.

EQUIPMENT OF FARM IN 1907.

Stock.	Value.	Machinery.	Cost.
2 horses	$200.00	1 potato planter	[illegible]
1 horse	200.00	1 potato digger	[illegible]
1 colt (2 years)	125.00	1 walking weeder, 12-foot	[illegible]
1 colt	50.00	1 plow, 14-inch	[illegible]
3 cows	300.00	1 harrow, 2-section	[illegible]
3 heifers, 2 years	225.00	1 wagon, secondhand 17 years ago	[illegible]
2 heifers, 1 year	80.00	1 delivery wagon, mostly homemade	[illegible]
1 bull calf	50.00	1 road wagon	[illegible]
50 hens	50.00	1 mower, 5-foot	[illegible]
		1 dump hayrake, 10-foot, secondhand	[illegible]
		1 side hayrake, secondhand	[illegible]
		1 manure spreader	[illegible]
		1 walking lister, secondhand	[illegible]
		1 plow, 1-shovel	[illegible]
		2 small platform scales	[illegible]
		1 cultivator, 14-tooth, 1-horse	[illegible]
		1 cultivator, 4-shovel, with 6-shovel spring shank attachment	[illegible]
Total	1,280.00	Total	[illegible]

a Estimates.

SALES, EXPENSES, AND NET INCOME OF FARM IN 1906.

Sales.	Value.	Expenses.	Cost.
½ tons hay	$25.00	1 cow	$50.00
Potatoes, 2,000 bushels, at 60 cents	1,200.00	257 bushels corn	94.45
cows	185.00	16 bushels wheat for poultry	8.60
calf	15.00	Oil, meal, and bran	10.00
½ bulls[a]	257.50	Labor	68.00
colt	70.00	Seed potatoes	[b] 90.00
Poultry	[b] 100.00	Pasture	[b] 15.00
Eggs	[b] 30.00	Miscellaneous	[b] 75.00
Strawberries	60.00	Taxes	[b] 25.00
Total	1,942.50	Total	436.05

[a] This item includes a half interest in 1 bull.

[b] Estimates.

Summary:

Value of farm, 40 acres at $200	$8,000.00
Value of live stock	1,280.00
Value of machinery and implements	484.00
Total	9,764.00
Sales	1,942.50
Expenses	436.05
Net income of farm	1,506.45

RETURNS ON INVESTMENT.

It will be seen that the net income derived is 15.4 per cent on $9,764, the total value of the farm, stock, and equipment. While more cattle were disposed of in 1906 than can be sold every year they did not bring more money than it is hoped the smaller number will bring when the herd is better established. In 1907 much more was realized from small fruit, but the acreage of potatoes was reduced one-half.

The sales usually amount to about $1,500 per annum, which, after paying expenses, leaves about $1,100 (or 11¼ per cent on the capital invested) and the produce used, which represents the income of the family or the amount available for living expenses and profits. That the family has been able to live on less than this is shown by the fact that the farm has been paid for practically in eleven years, improvements costing about $1,000 have been added, and the value of the live stock has been considerably increased. The place was purchased at $92.50 an acre, and is now worth about $200 an acre.

Considering the farm at its present value, the average net profit has been approximately $800 per annum. Without considering the rise in value of the land, but counting only the purchase price of the farm, the cost of improvements made, and the increased value of the stock, the net profits actually resulting from what has been produced have been not far from $500 per annum.

In comparing these results with those obtained in other line business or by men working for salaries, it must be remembered th all living expenses of the family were paid out of the receipts fr the farm and that these profits still remained. The home alone worth a large proportion of the value of the entire farm, yet this h been included in the investment upon which the percentage of pr has been figured.

All of the produce, poultry, eggs, butter, milk, and some fuel h also been supplied by the farm. These are items which no one w think of including in the business expenses of any other line of w To rent as good a house and live as well as this family does w require $1,500 a year in almost any city. And to do this and sav much as this farmer has netted would require a salary of about $2,

The owner of this farm had previously operated 160 acres for a number of years, but has done so much better on 40 acres that he h no desire for a larger area. He alone does practically all the w the farm, none of the other three members of the family ass the outdoor work.

SUGGESTIONS AS TO IMPROVED METHODS.

Under the present practice one mare does nothing but raise a co while the old team is probably not in use more than half the ti The work could easily be done by a team of brood mares. Two c a year could be raised instead of one, and the expense of keeping extra horse would be avoided.

The cropping system now in use is very irregular. Two years the are 7 acres of potatoes and the third year 14 acres. Three consecuti crops of potatoes on the same land are not advisable on account o danger from disease, but even if grown for three years the syst would still be just as irregular. One year there would be 7 acre old grass and two years there would be 7 acres of old grass and acres of new seeding. This makes the hay supply irregular. The h ration, too, can be much improved by the introduction of alfalfa. T correct these difficulties the following changes are suggested: Lay o the fields as shown in figure 2. This will not require any change fences, as no fences are needed between fields. It will eliminate th sweet corn fodder, but will supply alfalfa, which is more producti and a more valuable feed. A large proportion of the alfalfa will b near to the pasture and can conveniently be cut and thrown over the stock if necessary. There will be 3¼ acres of alfalfa, 4¾ acres ld grass, 4¾ acres of new grass, and 9½ acres of potatoes each yea ith a regular rotation of two years in grass and two years in p es. Assuming yields of 200 bushels of potatoes, 6 tons of alfa ons of old grass, and 1¼ tons of new grass to the acre, the propo plan gives 1,900 bushels of potatoes, 25 tons of timothy and clover hay, and 19½ tons of alfalfa, while the present plan gives an average of 1,833 bushels of potatoes, 34 tons of hay, and 6 tons of fodder.

By the change 67 bushels of potatoes and 4½ tons of feed are gained, a much better quality of feed is obtained, and a regular rotation, giving the same acreage in each crop each year, is adopted. The feed supply will therefore be more regular, as there will not be so much danger of a shortage or surplus of hay.

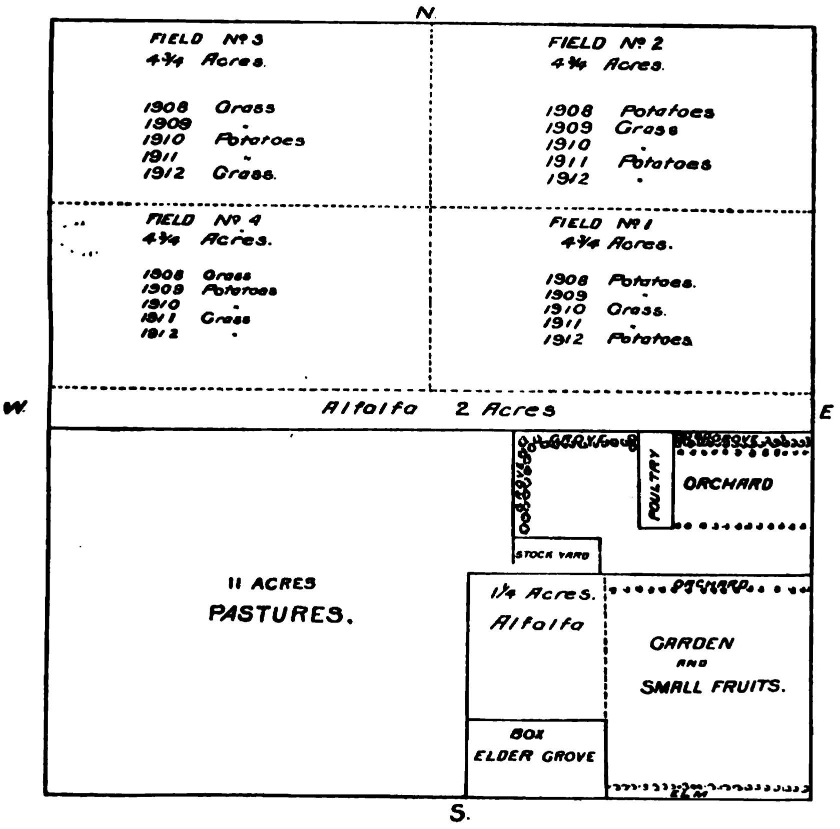

FIG. 2.—Diagram of the Beadle farm showing suggested improvements in arrangement.

Assuming the above yields, 2 horses, 2 two-year old colts, 2 yearling colts, 2 spring colts, 5 cows, 1 bull, 2 yearling heifers, and 4 calves can be kept, and about the same quantity of corn as now used will be needed. The pasture will usually summer this number of stock or at least has furnished feed enough for the last two years. In case of a scarcity of grass, stock could be pastured out at reasonable prices, or the pasture could be supplemented with alfalfa, and a little hay purchased in winter, if necessary. Some patches in the garden that will be vacant by the middle of the summer can be utilized for crops of feed.

The introduction of alfalfa will considerably improve the ration for both cattle and horses, as will be seen by examining appended table, which shows the food requirements of cattle of ferent ages according to the Wolff-Lehmann feeding standards, proximately the ration now used, and the proposed ration. The is assumed to be an even mixture of timothy and clover. If it be three-fourths clover and one-fourth timothy, the protein would be increased by one-fifth and the carbohydrates decreased one-twentieth.

TABLE I.—*Daily food requirements of cattle of different ages, the quantity used on the Beadle farm, and the ration proposed.*

Feed.	Dry matter.	Protein.	Carbohydrates.
CALVES (600 POUNDS WEIGHT).			
	Pounds.	*Pounds.*	*Pounds.*
Quantity required	15.00	1.50	7.9
Present ration:			
Hay (one-half clover, one-half timothy)—14 pounds	12.11	0.67	5.50
Corn—4 pounds	3.50	.31	2.67
	15.61	.98	8.17
Proposed ration:			
Hay (one-half clover, one-half timothy)—5 pounds	4.29	0.24	1.98
Alfalfa—8 pounds	7.30	.88	3.16
Corn—4½ pounds	3.50	.35	3.00
	15.09	1.47	8.14
YEARLINGS (900 POUNDS WEIGHT).			
Quantity required	21.60	1.60	10.80
Present ration:			
Hay (one-half clover, one-half timothy)—21 pounds	18.90	1.10	8.71
Corn—3 pounds	2.60	.20	2.00
	21.50	1.30	10.71
Proposed ration:			
Hay (one-half clover, one-half timothy)—10 pounds	8.58	0.48	3.97
Alfalfa—10 pounds	9.16	1.10	3.95
Corn—4 pounds	3.50	.31	2.67
	21.24	1.89	10.59
COWS (1,200 POUNDS WEIGHT).			
Same basis as cattle eighteen to twenty-four months.			
Quantity required	28.80	2.16	14.40
Proposed ration:			
Hay (one-half clover, one-half timothy)—20 pounds	17.10	0.96	7.92
Alfalfa—11 pounds	10.00	1.21	4.35
Corn—3 pounds	2.60	.20	2.00
	29.70	2.37	14.27

To feed the bull all the year and the other cattle six months tions will require 32,400 pounds of mixed hay and 23,100 alfalfa. This will leave 17,600 pounds of mixed hay and unds of alfalfa for the horses, which will feed the team months and the colts six months. If the cattle were grade stock it would probably be more profitable to feed no grain except, perhaps, to the calves, and even in this herd it may be found economical to feed less grain. When stock is to be prepared for show these rations would be inadequate.

A FORTY-ACRE FARM IN ADAMS COUNTY, NEBRASKA.

INTRODUCTION.

In December, 1895, Mr. H. F. Warren purchased 40 acres of unimproved rough land 10 miles from Hastings, south-central Nebraska. The price was $400 and a mortgage was given for the whole amount. He secured also a lease on 40 acres of tillable land for two years, giving one-third of the crop, and a lease on a house and outbuildings for two years. January 1, 1896, his business statement showed:

Resources	$942.85
Liabilities	648.80
Present worth	294.05

The lease on the buildings was valued at $100. The inventory was detailed and included everything in doors and out.

THE LAND.

The land purchased is cut by several deep draws and is one of the roughest pieces in the county. Most of it was in native grass, one-third is untillable, and the remainder is cut up into small patches by several deep ravines. Two acres were in public roads. There was no timber. The soil is of loessial origin and is mostly the dark silt loam so common in the Missouri basin. On many of the hillsides the dark soil has been washed off and the buff subsoil lies bare. Near the largest draws are some patches of fine sandy loam.

THE OWNER AND HIS PROSPECTS.

No one but the owner believed it possible to make even the most meager living upon such a farm—38 acres of rough pasture 10 miles from town, no buildings, no money, four mouths to feed, two hands to earn. The neighbors thought him foolish to try. It was certainly a hard-looking proposition, but the personal factors at least were in his favor. He was young and strong and possessed energy and determination. Both he and his wife knew how to make the most of everything. He was an experienced farmer and also knew something of garden and nursery work. He was handy with tools and could do practically all of his own smith, carpentry, and mason work. The figures on page 20, taken from the annual balance sheets, show what success has been attained.

MANAGEMENT.

The rented land was planted to corn, and as there was very little stock most of the crop had to be sold, but the price (8 to 15 cents a bushel) was too low to pay the cost of production. From 1898 to 190[illegible], inclusive, no land was rented. Work was at once commenced on the home place. The tillable land was subdued. Orchards were set and the bottoms of the draws, which were too frequently overflowed to produce crops, were set with forest trees.

POTATOES.

Several patches were recognized as good potato soil and in 1[illegible] potatoes became the main crop and continued so for at least five years. One year the cash sales of potatoes amounted to $450. Early marketing was resorted to as much as possible, and potatoes were frequently hauled 14 miles and seldom less than 10. Sale was often slow and continued till spring. Catch crops of sorghum, millet, or turnips frequently followed early potatoes. There was so little tillable land outside the orchards that rotation was not undertaken, and the continued growth of potatoes so filled the ground with disease that the crop had to be abandoned.

MISCELLANEOUS CROPS.

Not much truck has been grown because it is too far to market. Different years various small crops that were not regularly produced have been planted successfully. One year several acres of sorghum made a profitable crop of both seed and sirup. White beans were once an important item of income. Another year a catch crop of turnips after potatoes proved very profitable and the next season considerable turnip seed was sold.

ORCHARDS.

The orchards, of which there were 12 or 15 acres of apples, peaches, cherries, and plums, were ruined by severe storms and became a total loss. Most of the trees have been grubbed out or cut down. The labor and money spent upon them constituted a heavy loss to the owner.

TIMBER.

The forest trees have proved a great success and for several years have supplied an abundance of fuel. Unfortunately, most of the earlier settings were of maple and ash, which, though valuable for fuel, are worthless for posts. Later catalpas were set and promise soon to furnish all the posts needed and some to sell.

It should be emphasized that all these forest trees producing valuable timber are on land that would otherwise have been entirely waste. Many a farm in this region has enough such waste land to produce all the fuel and posts that can be used. If the proper varieties are set no better posts or wood can be had at any price. The importance of this will be seen when it is remembered that common small posts are worth 16 to 25 cents each and soft (bituminous) coal about $8 a ton.

STOCK.

In 1896 a herd of pure-bred hogs was started, but after several years was given up as a failure and for some time no hogs were kept. But since potatoes were abandoned most of the available land has been seeded to timothy, bluegrass, and alfalfa for hog pasture, and hogs for market have been the chief product of the farm in recent years. About 170 pigs were raised last year. All the grain is purchased. The pigs are farrowed in a large pig house, and as soon as conditions permit all sows and pigs are turned out together in the pastures. While the hogs are on pasture only a light feed of grain is given.

Concerning the character of the pasture it may be stated that part of it is rough land not suited to the plow and is in native prairie grass. A small portion of the pasture land is in bluegrass, another small portion in timothy, while several acres are in alfalfa. Sometimes the orchard is utilized as pasture for hogs. During the winter alfalfa hay and corn are fed.

The best old sows are kept over to bring fall pigs. The pigs are marketed at from 9 to 12 months of age. Mr. Warren is gradually bringing all available land on his farm into pasture and forage crops for hogs.

Two horses and 1 to 3 cows have always been kept. A good flock of hens—sometimes over 200—has added considerably to the income, as well as supplying the table with poultry and eggs.

LABOR.

Only a few days' work has ever been hired. Work is exchanged with the neighbors and sometimes grain has been taken in payment for work. Nearly every year a little money has been received for labor. This year (1907) the children are helping a good deal.

EXPENSES.

During the six years, 1896 to 1901, inclusive, the average annual cash expense for living, including clothing, furniture, fuel, groceries, doctor's bills, and every expense connected with the household, was only $66.44. Everything else used was either produced on the fa or secured in exchange for produce. At the beginning of this per there were four persons in the family and at the end seven.

For the eight years ending in 1903 the average annual farm exp exclusive of permanent improvements, stock, and feed, but includi machinery, repairs, and incidentals, was $35.23.

These items show how nearly a family may live upon the prod of the farm and how low an ingenious man may keep the incide expenses of the farm.

RESULTS ACCOMPLISHED.

From 1896 to 1903 a business statement was made out each year, a the following table shows the financial condition on January 1 of year:

TABLE II.—*Business statements for the Warren farm from 1896 to 190 inclusive.*

Year.	Real estate.	Lease.	Cash.	Machinery.	Live stock.	Feed and supplies.	Household goods.	Total resources.	Total liabilities.	Present worth
1896	$400.00	$100.00	$92.85	$113.00	$96.00	$31.00	$110.00	$942.85	$648.05	[illegible]
1897	400.00	50.00	6.90	70.00	165.00	82.25	110.00	849.15	577.00	[illegible]
1898	550.00	--------	69.48	82.00	402.00	2.95	75.00	1,473.48	618.78	[illegible]
1899	700.00	--------	1.67	57.00	235.00	63.00	75.00	1,131.67	555.70	[illegible]
1900	1,000.00	--------	.02	89.00	220.00	179.00	75.00	1,563.02	450.90	[illegible]
1901	1,000.00	--------	.00	79.00	205.00	138.00	75.00	1,497.00	[a] 10.00	[illegible]
1902	1,200.00	--------	.00	105.00	115.00	145.00	80.00	1,645.00	[a] 10.00	[illegible]
1903	1,350.00	--------	6.53	95.00	147.00	156.00	80.00	1,834.53	[a] 10.00	[illegible]

[a] Taxes, estimated.

In the autumn of 1906 land was rented and teams and mach purchased to operate it, because two of the boys are now large eno to help. Had it not been for this expansion, the hogs sold the close of 1906 would have paid all debts and the running exp through the next summer. There were also on hand—

Cash	$65.00	Household goods	[illegible]
2 horses	150.00	Machinery and tools	[illegible]
3 cows	90.00	Feed and supplies	[illegible]
11 hogs	200.00	Farm	[illegible]
78 fall pigs	273.00		
Poultry	12.00	Total	[illegible]

[a] Possibly this is as much as these goods would have brought on the This includes a collection of mounted animals and birds which it is not that any taxidermist would sell for less than $200, and it is worth much than it was in 1896 when the owner invoiced it at $40. The writer wou mate the household goods exclusive of the specimens at $150.

[b] The farm was not for sale and could not have been purchased at price.

The buildings and fencés cost probably $1,400 for material alone. 'he increase of $2,600 in the value of the farm since it was purchased 'ould probably not pay the cost of the improvements that have been ıade if orcbards and groves are included. The owner of this farm as worked hard and the family has lived economically, but most of ıe time many of the comforts of life, as well as the necessities, have een enjoyed and the children have been kept in school. There has ˡways been time to care for the hundreds of flowering perennials nd shrubs and ornamental trees which almost hide the house from iew. To start with $294 capital and in eleven years have over $4,200 nd care for two to seven children all the time is certainly a very ood showing for 38 acres of rough land. Two acres of the 40 are ı public roads. No land was rented until 1907, except the first two ›ars, and that did not pay expenses.

A TWENTY-ACRE FARM IN PAWNEE COUNTY, NEBRASKA.

INTRODUCTION.

Ten years ago Mr. Arnold Martin, a young Swiss farmer, who as result of three years' renting in northeastern Kansas had secured team, a little farm machinery, and $275 in money, became dissatis-›d. He had been raised on a 6-acre farm, had studied agriculture the public schools, and knew something of intensive methods. e believed he could do better on a small place of his own than on large rented farm. In Pawnee County he found 20 acres of unim-oved rough land mostly covered with brush and small trees. Good nd was worth $50 to $70 per acre, but no one seemed to want this ece. He purchased it for $12.50 per acre, paying $100 down and ving a note for $150 at 7 per cent interest for three years. There mained $175 with which to make improvements and start his work. 'alizing that it would take several years to subdue most of his n land, he leased an adjoining piece of about 4 acres for five years. ıis was also unbroken and needed considerable clearing.

While grubbing, plowing, and planting, the owner was studying › markets and his soil to see what he could produce for which there s a home demand. Potatoes, onions, small fruits, pears, and aches were chosen for the main crops, with corn for any land t otherwise occupied.

THE SOIL AND ITS USE.

\ small field of nearly 2 acres of alluvial soil is kept for annual ›ps. The slopes are rocky in places and the soil is a residual y loam, having been formed mostly by the weathering of the limestone which underlies it. About 8 acres of this are set to orchar about 1 acre in alfalfa, 1 in timothy and clover, 3 in pasture (of which is timbered), and a little in annual crops. One hill is p soil, largely formed by glacial deposits, and contains some bowld locally called " nigger heads." About 2 acres of this is in wild gr which is used for hay, as is also about half an acre of stony l around the quarry. There is still a little land that has not be put to use.

METHODS AND PRACTICES.

The intensive methods practiced are of particular interest. T land is kept busy from spring till fall. At the last cultivatio the potatoes corn is planted between the rows. A full crop of p toes is secured and a fair crop of corn also. As many as 75 bushe corn to the acre have been grown in this way. The corn usually to be hoed once, but the potato vines nearly cover the ground. not much working of the corn is required. After the potatoes rip the corn keeps the weeds down. By the time the corn needs the gr the potatoes are ripe, and the corn is in the shock before it is tim dig the potatoes. Squashes are sometimes planted the same w Usually parts of the potato patches are sown with millet or sorg just before the last cultivation. This makes a good crop of fe and does not hurt the potatoes. The smallest yield of potatoes ev secured was 100 bushels an acre and the largest over 700 bushels acre. The onion patches grow corn and melons, which are plan in the rows between the onions. Part of the orchard is set w small fruit and part is planted with potatoes and truck.

In dry spells all the water the windmill will pump is used f irrigation, and it is here that intensive cropping reaches its hei There is also a small irregular spring which flows into a reser and at times furnishes considerable water. The water from the w flows directly to the ditch as pumped. A little manure is scatte in the ditches to prevent washing.

The accompanying diagram (fig. 3) shows the rows of crop two of the spaces between rows of pear trees. The pears have b set six years and the limbs touch in the rows, yet nearly all the ot plants were doing well when the writer visited the farm late June. The trees are 10 feet apart in the rows and the rows 12 f apart.

MANURE.

On account of the soil being new, not so much manure has b required as will be needed in the future. All that is made on farm is used and all that is wanted can be obtained two miles dista All cornstalks and coarse waste are used to prevent washing or mulch trees or berries that can not be cultivated. About two loads of wood ashes are secured annually and used on strawberries and pear trees.

FRUIT.

The orchards contain 900 pear, 200 cherry, about 800 peach, and a few apple trees; 200 plums were set, but have been grubbed out because they were not profitable.

Pears have paid the best. Many varieties have been tried. Some varieties are not readily self-fertilized, especially the Kiefer, so it was necessary to find varieties that flowered at the same time, as well as those that were hardy and prolific. The best success has been attained by planting Dwarf Duchess and Standard Kiefer alternately. Standard Flemish Beauty has also done well.

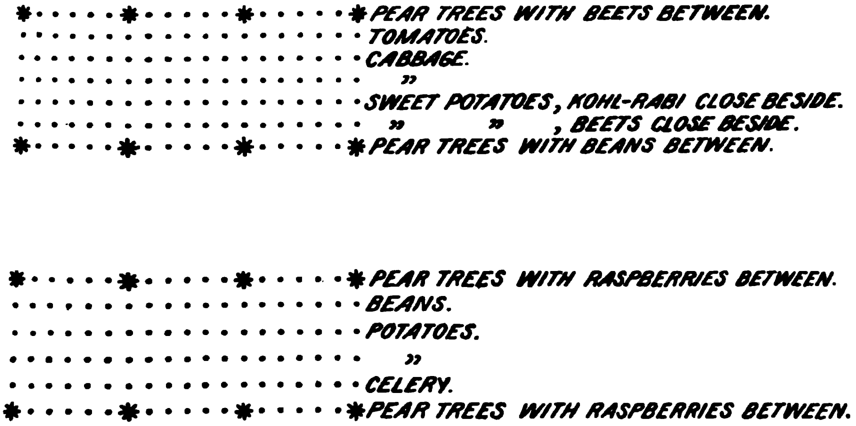
PEAR TREES WITH BEETS BETWEEN.
TOMATOES.
CABBAGE.
"
SWEET POTATOES, KOHL-RABI CLOSE BESIDE.
" " , BEETS CLOSE BESIDE.
PEAR TREES WITH BEANS BETWEEN.
PEAR TREES WITH RASPBERRIES BETWEEN.
BEANS.
POTATOES.
"
CELERY.
PEAR TREES WITH RASPBERRIES BETWEEN.

FIG. 3.—Rows of crops in the pear orchard on the Martin farm.

Of the small fruits strawberries have given the best returns, but good many raspberries and blackberries have been grown, and some gooseberries and currants.

SEED CORN.

The production of corn for seed and for exhibition has been underaken as a side issue and is proving very successful. Mr. Martin on a gold medal on corn at the St. Louis Exposition. At other airs many premiums have been awarded his products. He finds ady sale for seed corn at good prices. When corn is grown without ny other crop cultivation is continued until the ears are well maired. Contrary to the practice of most breeders, Mr. Martin plants e best ear in a patch by itself, and the best ear from the crop is lected and planted in the same manner. The prizes he has won do t make a bad showing for his practice.

EXHIBITS OF FARM PRODUCTS.

The last few years considerable attention has been given to gr ing a large variety of products for exhibition purposes. Last y $243.25 in cash prizes was secured. At the Portland Exposition th gold and two silver medals were won.

SPRAYS.

Mr. Martin is an enthusiastic advocate of dust sprays and u Bordeaux mixture frequently on orchards and truck. Arsenical p sons are used as insecticides. His plants and trees have a very hea appearance and the pear orchard is probably the best in the State, b it must be remembered that the trees are still young.

LABOR.

No labor is ever hired. The owner, with the help of his wife, d it all, and besides has earned considerable money every year, ex the last, by helping his neighbors. He has more work now than he can well do at home and may soon have to hire help.

MISCELLANEOUS.

No butter, eggs, or poultry have ever been sold. Only a f chickens are kept for family use, and these, on account of the cr they might destroy, are closely confined during the growing sea Only one cow is kept. When there is a surplus of rough feed, ca are bought, fed through the winter, and sold in the spring. S hogs are now kept to make use of unsalable products.

EQUIPMENT.

Stock.	Machinery.
1 team of mules.	1 wagon.
1 cow.	1 mower.
1 1-year-old driving colt.	1 hayrake.
1 sow.	1 cultivator, 4-shovel, 2-horse.
A few chickens.	1 cultivator, 5-shovel, 1-horse.
	1 harrow, 2-section.
	1 walking lister.
	1 walking plow.
	1 hand cultivator.
	1 garden drill.
	1 hand sprayer.

INCOME AND EXPENSES.

The following shows the receipts for produce sold from the farm for the past ten years. Exact accounts of everything have been kept. To this should be added about $100 received for rock quarried on the farm by the owner's labor. The profit on the calves which have been wintered should also be added, but the amount is unknown:

1897.

3 acres potatoes, 678 bushels at 50 cents	$339.00
8 acres corn, 220 bushels at 32 cents	70.40
One-half acre vegetables	72.00
Received for helping neighbors	58.00
Total	539.40

1898.

5 acres potatoes, 930 bushels at 45 cents to $1	$418.50
12 acres corn, 170 bushels	53.20
Strawberries and vegetables	126.30
Received for helping neighbors	103.00
Total	701.00

1899.

7 acres potatoes, 1,085 bushels at 35 cents	$379.75
12 acres corn, 230 bushels at 30 cents	69.00
One-half acre small fruit and vegetables	136.40
Received for helping neighbors	46.20
Total	631.35

1900.

10 acres potatoes, 1,260 bushels at 40 cents	$504.00
12 acres corn, 220 bushels at 32 cents	70.40
One-half acre vegetables	82.60
One-half acre small fruit, 126 crates at $1.60	201.60
Received for helping neighbors	36.40
Total	895.00

If too many acres appear to be accounted for, it must be remembered that much of the land raises two crops.

1901.

acres potatoes, 710 bushels at $1 to $2	$810.00
acres corn (none sold).	
Small fruit and vegetables	69.50
Received for helping neighbors	28.00
Total	907.50

This was a very dry season and the thorough cultivation pra
told well on the potato crop.

1902.

5 acres potatoes, 1,600 bushels at 25 cents	[illegible]
10 acres corn, 280 bushels at 35 cents	[illegible]
Small fruit	[illegible]
Received for helping neighbors	[illegible]
Total	[illegible]

1903.

Potatoes, at 80 cents to $1.50	[illegible]
Received for work at college	[illegible]
Total	[illegible]

In 1903 half the land was rented and the owner spent three
away from home starting a farm for a college. This made th
ceipts for the year very low.

1904.

5 acres potatoes, 8 acres corn, etc.:

Potatoes, 750 bushels at 75 cents	[illegible]
Corn, 210 bushels at 40 cents	[illegible]
Small fruit and vegetables	[illegible]
Received for helping neighbors	[illegible]
Total	[illegible]

1905.

6 acres potatoes, 7 acres corn, etc.:

Potatoes, 892 bushels at 60 cents	[illegible]
Corn, 168 bushels at 40 cents	[illegible]
Seed corn, 46 bushels at $1.50	[illegible]
Small fruit and vegetables	[illegible]
Received for helping neighbors	[illegible]
Total	[illegible]

1906.

4 acres potatoes, 8 acres corn, etc.:

Potatoes, 350 bushels at 55 cents	[illegible]
Corn, 120 bushels at 36 cents	[illegible]
Pears, 286 bushels at $1.20	[illegible]
Seed corn, 38 bushels at $1.75	[illegible]
Premiums	[illegible]
Hogs	[illegible]
Total	[illegible]

RESULTS ACCOMPLISHED.

The results accomplished, as shown in the foregoing statements, have not been obtained by catering to fancy city trade. The nearest market of any consequence and the one where most of the produce has been sold is a town of 2,500 inhabitants 7 miles distant.

In 1899 the mortgage of $150 was paid; in 1902 a barn was built at a cost of $100; in 1903 a well, a windmill, etc., were built costing $100, and an addition to the house, costing $200, was made. The fencing used cost about $50.

The home is now comfortably furnished and practically all has been paid for in ten years. The other expenses of the farm have been very light except for nursery stock, which has probably cost $800. The house is a neat little four-room cottage. The barn has a stone basement, 16 feet by 20 feet, for stock and an upper story for grain and hay.

Mr. Martin now owes no one and has some money ahead. The farm could easily be sold for $2,500. The owner has made three pleasure trips to Colorado and spent three months last winter in Switzerland. He has found time also to gain a good command of English, both spoken and written.

Mr. Martin says his place is far from producing what it is capable of; in fact, there are several acres that have as yet produced almost nothing. He expects to do much better in the future. It will readily be seen that much time and money have been spent on orchards which have only just commenced to bear.

The neighbors used to laugh at the young foreigner and nicknamed him "Hazelbrush," but now they say, "He is making more money on 20 acres than we do on 160." He does not want any more land, but wants to farm what he has better. In speaking of the size of farms he once said: "People of moderate means should not farm too much land. A man can start on 20 acres; 40 acres will do; 80 is enough; 160 an abundance; 320 a misfortune; and 640 a calamity."

GENERAL CONCLUSIONS.

Nothing in this bulletin should be interpreted to mean that the time has come when the average farm in the corn belt should be reduced to 20 or 40 acres. We do not mean any such thing. It seems perfectly clear that the majority of farms should contain 80 to 160 acres. There is no reason why the man who owns a large farm and has means and help to operate it should reduce his acreage. But the man who must depend mainly on borrowed money or is unable to secure sufficient help often overreaches and reduces his profits or creates an actual loss in consequence, when if he had been content to work on a smaller scale, depending mostly upon his own labor and as little as possible upon borrowed funds, success would have been much more certain.

Even the man on a 160-acre farm must depend largely upon making a profit from hired labor. His margin usually is not large and his risk is considerable. He must commonly be content with a very moderate return upon his investment. There are many details which must too often be entrusted to incompetent or indifferent persons, and many small losses and leaks occur that could be prevented if the owner had less to look after. The small farmer can not expect to clear as much as the larger one in the most favorable seasons, but on the other hand his loss will be much less in unfavorable seasons. He has less risk not only because he has less invested in land, but especially because he has less invested in teams, machinery, feed, etc., and has entirely eliminated the very important item of expense for hired help, and also because he can keep closer watch of everything and in case of sudden or unforeseen contingencies, such as sudden storms, can care for his smaller acreage more quickly. Generally, too, his income will be more evenly divided between several products than is that of the larger farmer, and consequently his chances of heavy loss are very much reduced. In case of poor crops the small farmer can lose little besides his living expenses because his running expense is very small, but the large farmer who operates on borrowed capital has his interest to pay and heavy running expenses, including hired labor. One adverse season may consume the profits of several favorable ones.

The capital invested in a small farm is often of minor importance, the owner's labor being the main producing factor, but on large farms or even on farms of moderate size interest on the investment may be much more than the value of one man's labor. Nearly everything on the small farm returns a larger percentage of profit because everything receives the owner's personal attention. He does all the work and does it much better than hired men can be expected to, and this difference is often enough to make the difference between a [illegible] and a good profit.

Generally the man on less than 80 acres can not afford to grow much grain. As a rule, he should aim to produce things that are shipped into his home town rather than those that are shipped out. A glance at any grocer's stock is sufficient to show that he is obliged to import much that could be profitably grown in the vicinity. Strawberries, blackberries, grapes, melons, cabbage, tomatoes, onions, sweet potatoes, and potatoes are among the products that are annually shipped into many of the towns in this region and during the season when they could be supplied by the neighboring farms. Of the products adapted to small farms for which there is a more general market, hogs and alfalfa will probably take the lead. Dairying can always be resorted to; the growing of improved seed corn can well be handled on the small farm; 100 or more hens can always be made profitable. No one man will produce all of these, and for that reason there is room for several small farms near every town of even a few hundred inhabitants. Near the larger cities small farmers, truckers, and dairymen are numerous and competition is close, but still there is room for more men with energy and intelligence who are quick to see what can be produced at a good profit.

No small farmer should depend entirely upon any one product unless it be a dairy product. Danger of failure is too great and there is not an economical distribution of labor. There will be too much to do at one season and nothing at another.

A few cows, a few hogs, and a good many hens will work in nicely with almost any combination of crops. If many hogs are kept most of the farm should be in alfalfa, and hay and hogs would be the products sold. Potatoes or seed corn can be handled with hogs and alfalfa. Often a pasture has to be plowed up, and this makes an excellent place for either corn or potatoes. If cream or butter is to be sold, enough hogs should be kept to make profitable use of the milk. The number of types of farming and combinations of crops that can be adopted is very large, and the writer has intended to mention only a few and not to exhaust the list. It will be seen that some of these types are almost independent of local markets.

Every man must make a careful study of the local conditions, his own preferences, and the crops and stock he selects. Of these he should become an expert producer. Every foot of ground should be kept busy as much of the time as possible and to do this catch crops, such as turnips, pumpkins, millet, sorghum, and early varieties of corn planted late for feed, must often be resorted to. Frequently before one crop is off the ground another may be started. The producing power of the soil must be kept at the maximum by the use of manure and leguminous crops.

It is not the intention of the writer to encourage city men who know nothing of farming to go on to farms expecting easy work and large profits. Without economy and hard work success should not be expected on any farm. Experience is as necessary as in any other line of work. The more intensive the methods the more necessary experience becomes. It is true that inexperienced men frequently make successful farmers from the start, but this is also true of any other line of business. It should be emphasized that each of the men whose farms have been described was young, strong, and full of energy; that he was an experienced farmer and already familiar with the locality before starting on his small farm.

FARMERS' BULLETINS.

he following is a list, by number, of the Farmers' Bulletins available for distribution. e bulletins entitled "Experiment Station Work" give in brief the results of experints performed by the State experiment stations. Titles of other bulletins are -explanatory. Bulletins in this list will be sent free to any address in the United tes on application to a Senator, Representative, or Delegate in Congress, or to the retary of Agriculture, Washington, D. C. Numbers omitted have been discontinl, being superseded by later bulletins.

The Feeding of Farm Animals. Pp. 40.
Hog Cholera and Swine Plague. Pp. 16.
Flax for Seed and Fiber. Pp. 16.
Weeds and How to Kill Them. Pp. 30.
. Souring and Other Changes in Milk. Pp. 22.
. Grape Diseases on the Pacific Coast. Pp. 15.
. Silos and Silage. Pp. 30.
. Peach Growing for Market. Pp. 24.
. Meats: Composition and Cooking. Pp. 31.
. Potato Culture. Pp. 24.
. Cotton Seed and Its Products. Pp. 16.
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FARMERS' BULLETIN 326.

BUILDING UP A RUN-DOWN COTTON PLANTATION.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., March 17, 1

SIR: I have the honor to transmit herewith a paper entitled "B ing Up a Run-Down Cotton Plantation," by Mr. D. A. Brodie, As ant Agriculturist, Farm Management Investigations. This p is an account of three years' operations on the farm of Mr. J Walker, of Latour, Ark., in changing a worn-out cotton planta into a profitable stock and hay farm. I recommend that it be p lished as a Farmers' Bulletin.

Respectfully,

B. T. GALLOWAY,
Chief of Bur

Hon. JAMES WILSON,
Secretary of Agriculture.

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BUILDING UP A RUN-DOWN COTTON PLANTATION.

INTRODUCTION.

This bulletin is an account of the progress made in three years in changing a run-down cotton plantation into a profitable stock and hay farm. The results obtained from the use of cowpeas and other leguminous crops in restoring the fertility of the land have exceeded the expectations of those in charge of the work. Not only have the crops yielded greater returns each year, but all the grain and hay necessary to feed 14 brood mares, 1 jack, 2 driving horses, 1 saddle horse, a varying number of mule colts, a cow and calf, and from 50 to 75 hogs has been raised and a considerable surplus of grain and hay sold each year.

However, it is only fair to state that all of the credit for this increased production is not due to the legumes alone, because at the start an entirely new system of farming was put into operation; modern implements took the place of the old ones, the land was plowed deeper, better drainage established, improved seed introduced, and better methods of cultivation practiced, each doubtless contributing something to the general improvement.

GENERAL CONDITIONS IN 1905, 1906, AND 1907.

The farm referred to in this bulletin consists of about 375 acres of slightly rolling land at the foot of Crowleys Ridge, in Phillips County, Ark. The soil is a reddish silt loam, with occasional patches of sandy loam. The lower levels of the farm ate very poorly drained, and in consequence the crops on these portions have suffered greatly during seasons of excessive rainfall.

For upward of fifty years the crops have been for the most part cotton and corn, grown under the tenant system common in the South. .

As a result of this practice for so long a period the land was reduced to a very unproductive state. Table I gives a very good idea of the condition of the land at the time when the owner, Mr. Jo. M. Walker, not satisfied with the poor returns from the farm, took direct charge of it.

TABLE I.—*Crops, acreage, and yields of farm for 1905.*

Crop.	Area in acres.	Yield to the acre.	Total yield.
Cotton	140	¼ bale	35 bales.
Corn	80	15 bushels	1,200 bushels.
Oats	20	20 bushels, estimated	400 bushels.
Cowpeas	80	1½ tons of hay, 8 bushels of grain.	120 tons of hay, 640 bushels of grain.

The general average yield of cotton for the United States for
was 0.4 of a bale per acre and of corn for the same year 28.8 bu-
almost double in each case the yields given in this table.

On the other hand, note the satisfactory yield of hay and
from the cowpeas and the influence they had on the land, wh
shown in the increased yields in 1906, given in Table II.

TABLE II.—*Crops, acreage, and yields of farm for 1906.*

Crop.	Area in acres.	Yield to the acre.	Total yi
Cotton	6	½ bale	3 bales.
Corn	50	37.5 bushels	1,875 bushels.
Oats	15	30 bushels, estimated	450 bushels.
Cowpeas	120	0.966 ton of hay, 9.5 bushels of grain.	116 tons of hay, 11 els of grain.
Red clover	2	3 tons of hay	6 tons of hay.

In this case the yield of cotton was doubled after one cro
cowpeas and the yield of corn increased 2½ times that of th
vious year.

Table III shows continued improvement from the use of le
nous crops on this land.

TABLE III.—*Crops, acreage, and yields of farm for 1907.*

Crop.	Area in acres.	Yield to the acre.	Total yi
Cotton	12	0.708 bale	8.5 bales.
Corn	50	34 bushels	1,700 bushels.
Oats	20	30 bushels, estimated	600 bushels.
Cowpeas	60		

Here the general average for the season is nearly three-fourt
a bale of cotton per acre, almost three times the yield for
while the yield of corn is more than double that for 1905.

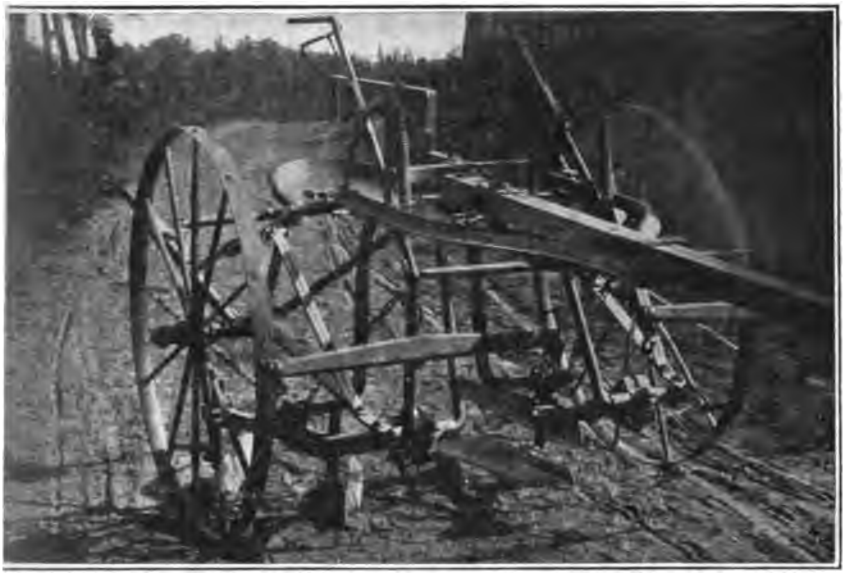
In order to better understand the figures given in Tables I,
and III, the various operations during the three years will b
cussed in detail.

COMPARISON OF THE OPERATIONS WITH COTTON FOR 1905, 19 AND 1907.

Previous to 1905 this plantation had the local reputation of
both poor and unprofitable. In 1905, as the records show,
yield of cotton was one-fourth of a bale to the acre. The crop
raised by negro tenants who broke the ground in the usual wa
"pony" plows and bedded and cultivated it with single mule te

In 1906 six acres were planted in cotton, following a crop of
peas. This cotton was raised entirely with hired help. The
was plowed deep with a 2-horse walking plow and afterwards

nd planted in the usual way, chopped twice, and cultivated shallow our times with a surface cultivator (fig. 1). The yield was one-half ale to the acre.



IG. 1.—Cultivator used in cultivating cotton and corn by the check-row system. Note the wide, sharelike shovels, especially adapted for shallow cultivation.

The land for the 1907 cotton crop was broken with the plow set to un 10 inches deep, double disked (fig. 2), and harrowed with a secion harrow (fig. 3). This implement is also known as a smoothing harrow or spike-toothed harrow.

A few days later the land was again double disked and harrowed as before. It was hen laid off with a check-row marker, with the hills 3 feet inches apart each way. The seed, a ong-staple variety, Floradora, was dropped by hand and covered with a ection harrow. Later the cotton was thinned to one talk to the hill and cultivated five imes with a sulky cultivator. The cultivating was done both ways and there was no hoeing.

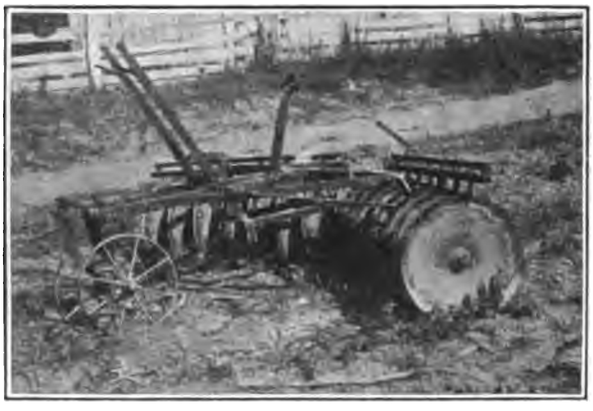


FIG. 2.—Tongueless disk harrow used effectively in preparing land after deep plowing.

As will be seen from Table IV, this crop is considered in
parts:

(1) Four acres, planted after one crop of cowpeas; (2) six a
planted after one crop of cowpeas, with 300 pounds of 8—2—2 com
cial fertilizer to the acre; (3) two acres, on land that had be

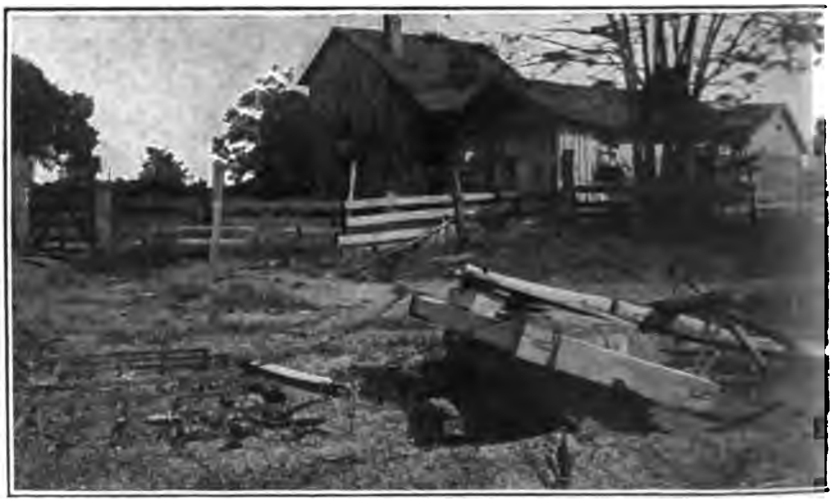


Fig. 3.—Section harrow attached behind roller to save labor.

cowpeas and clover continuously for two years and during that t
two light crops of clover had been turned under. For detail
the paragraphs on red clover later in this bulletin.

Table IV.—*A comparison of the operations and yields of cotton for 1905, 1906, an*

Year.	Area in acres.	Previous crops.	Preparation of land.			
			Fertilizer.	Plowing.		After-cultiva
				Date.	Depth in inches	
1905	140	Cotton and corn	None	March and April.	Shallow	Bedded.
1906	6	Cowpeas, 1 year	do	January	10	Do.
1907	4	do	do	do	10	Double disked harrowed t
	6	do	300 pounds	do	9	Do.
	2	Cowpeas and clover, 2 years.	None	April	10	Do

Year.	Planting—	Cultivation—
1905	With cotton planter	With mule and pony plow
1906	do	Chopped twice and cultivated four times with surface cultivator.
1907	By hand in check rows, 1 bushel to 5 acres, May 13.	Thinned to one stalk and cultivated five times with surface cultivator.
	do	do
	do	do

The 4-acre field yielded one-half bale to the acre; the 6 acres, hree-fourths of a bale; and the 2 acres, 1 bale per acre, an average for he whole crop of nearly three-fourths of a bale per acre (see Table II). This is a striking example of the beneficial effect of leguminous rops in building up exhausted soils. Especially is this true when ve realize that the yield of cotton in 1904 on this land was only oneourth of a bale to the acre.

Mr. Walker has kindly furnished an itemized statement of the perations on the 2-acre plot, which is presented here.

Statement cf operations on 2-acre plot.

EXPENSES.	
Breaking, at $1 an acre	$2.00
Disking (double disking twice)	1.50
Harrowing three times	1.50
Marking both ways	.75
Seed, 12 pounds,[a] at 10 cents	1.20
Cultivating five times and thinning	6.00
Picking 3,400 pounds of seed cotton, at 60 cents	20.40
Ginning 1,003 pounds of lint, at 80 cents	8.02
Land rent, at $3 an acre	6.00
	47.37
RECEIPTS.	
Two bales lint, 1,003 pounds, at 14½ cents	145.43
2,200 pounds of seed, at $3 per hundred	66.00
	211.43
Less expenses	47.37
Net profit	164.06
Profit to the acre	82.03

Commenting on this statement, Mr. Walker says:

> I have figured this cotton seed as worth $66 per ton and have sold most of it at that price. I paid for the seed I planted at the rate of $80 per ton and think it is a cotton particularly adapted to upland raising. It produced on this plot a 1⅜-inch staple and is a 5-locked cotton easy to pick.
>
> The figures given herewith are correct, and under our method of cultivation the expense would have been lessened considerably per acre if the planting had been made in a large field. There is a fence surrounding this plot and the ground contains several trees. Time was therefore wasted in turning.
>
> I am convinced that more cotton can be produced by checking one stalk 3 feet 4 inches each way and giving thorough shallow cultivation than by planting in drills, and the saving in seed will pay for the cost of planting by hand.
>
> The cost of cultivating can be lessened one-half. The time required to get over the crop with a 2-horse cultivator is so greatly lessened that the danger of being "caught in the grass" by a period of wet weather is reduced to the minimum.

---

[a] It seed is good, 5 pounds of seed per acre is sufficient; the remainder was used in replanting.

COMPARISON OF THE OPERATIONS WITH CORN FOR 1905, 190 AND 1907.

The beneficial effect of legumes on this land, as shown in increased yields of cotton, is almost duplicated in the case of crops for the same three years.

In 1905, 80 acres that had previously been cropped almost ex sively to cotton and corn were plowed deep in February and pla with the check-row planter on May 15. Cultivation was given Ju and repeated every ten days—four cultivations in all. The yie 15 bushels per acre.

In 1906, 50 acres on which a crop of cowpeas was grown the before were plowed deep in January with a gang plow (see fi

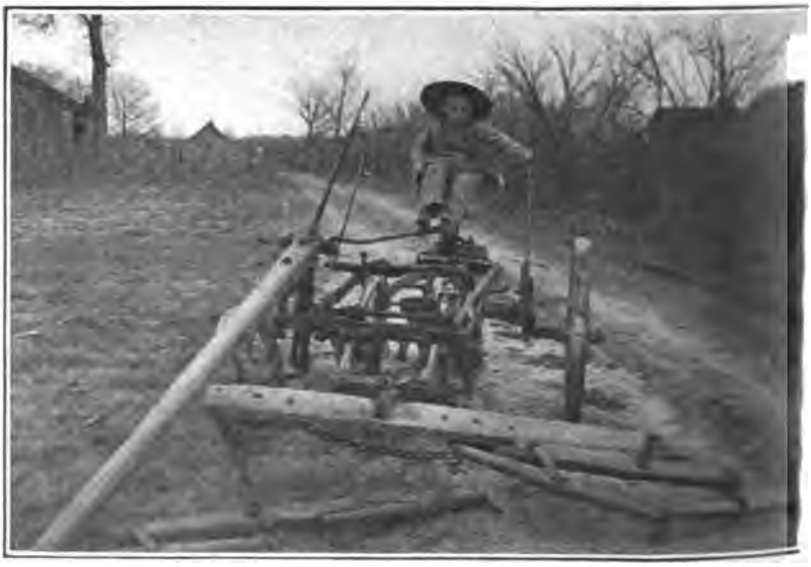


FIG. 4.—Gang plow, with which one man can plow five acres a day.

double disked, and harrowed with a section harrow. About Ap 15 the corn was planted with a check-row planter, two grains hill. Two varieties of seed from Illinois were used, 25 acres planted to Ninety-Day Dent and 25 acres to Boone County Wh The ground was harrowed immediately after planting and again w the corn was 3 inches high. In ten days it was cultivated with surface cultivator, again in two weeks, and a third time four we later. The yield was 35 bushels to the acre for the Ninety-Day and 40 for the Boone County White, an average of 37½ bushels for season's crop. (See Tables II, III, IV, and V.)

TABLE V.—*A comparison of the operations and yields of corn for 1905, 1906, and 1907.*

Year.	Area in acres.	Previous crops.	Preparation of land.			Seeding.		
			Plowing.		After-cultivation.	Date.	Rate.	Method.
			Date.	Depth in inches.				
1905	80	Cotton and corn.	February.	10	....	May 15	1 bushel to 7 acres.	Check row.
1906	50	Cowpeas....	January..	10	Disked and harrowed.	Apr. 15	2 grains per hill.	Do.
1907	15	.....do......	January and February.	10	Disked twice; harrowed twice.	Mar. 23	.....do....	Do.
	2	.....do......	.....do....	10	.....do............	May 15	.....do....	Do.
	15	.....do......	.....do....	10	.....do............	July 5	.....do....	Do.

Year.	Cultivation.			Average yield per acre in bushels.	Remarks.
	Intervals.	Number of times.	Implement used.		
1905	Every 10 days.	4	2-horse surface cultivators.	15	Cultivated 4 times with 2-horse surface cultivators.
1906	.....do....	4	.....do............	37.5	Harrowed when corn was 3 inches high; was neither thinned nor hoed. Cultivated every 10 days.
1907	....do....	4	.....do............	40	Same as above.
	....do....	3	.....do............	25	Badly damaged by cutworms; also suffered from drought.
	....do....	2	.....do............	40	Harrowed when 3 inches high, and as there was continued dry weather harrowed again when 6 inches high. Weather continued dry and yield attributed to second harrowing.

The corn land for 1907 was prepared, planted, and cultivated the same as for 1906 and followed one crop of cowpeas. The seed used was that saved from the 1906 crop. Fifteen acres were planted March 23 and yielded 40 bushels to the acre, 20 acres were planted May 15 and yielded 25 bushels to the acre, and 15 acres were planted July 5, yielding 40 bushels to the acre. The average for the year was 34 bushels to the acre, or 3½ bushels less than the average for 1906. This loss is doubtless due largely to the fact that the planting on May 15 was badly damaged by cutworms and also suffered greatly from drought, considerably reducing the general average for the season.

In this connection it may be stated that Mr. Walker has found it advisable to plant corn at different dates, so that in case of an unfavorable season all of the crop will not suffer. He also finds that early planting insures early feed, but requires more frequent cultivation (see Table V). However, the cultivation is practically over by the time hot weather sets in. (See Table VI.)

LEGUMINOUS CROPS.

COMPARISON OF THE OPERATIONS WITH COWPEAS FOR 1906, AND 1907.

It has already been shown that cowpeas have played the important part in the improvement of the land of this farm. further study of the operations during these three years it is that they have not only added very materially to the supply of and grain for home consumption, but have also yielded a surplus that has proved a valuable source of revenue.

TABLE VI.—*A comparison of the operations with cowpeas in 1905 and*

Year.	Area in acres.	Preparation of land.	Seeding.			
			Date.	Method.	Rate.	Implements used.
1905	80	Plowed and harrowed.	May 1 to 7	In drills 6 inches apart.	1¼ bushels.	Grain drill.
1906	120	Plowed, disked, and harrowed.	April 20 to July 20.	In drills 6 inches and 12 inches apart.	1 bushel and ½ bushel.	...do...

Year.	Yield per acre.	Total yield.	Amount sold.	Price received.
1905	1.5 tons 8 bushels	120 tons 640 bushels	20 tons 100 bushels	$15 per ton $2 per bushel
1906	0.966 ton 9.5 bushels	116 tons 1,140 bushels	100 tons 1,000 bushels	$15 per ton $2.25 per bushel.

In 1905, 80 acres were plowed in the early spring, harrowed planted to cowpeas the first week in May. The seeding was with a grain drill, with all the tubes open, at the rate of 1¼ bus to the acre. When about two-thirds of the pods had turned yellow mower was started and the peas cut for hay. Each day's cut was raked up the next morning, while there was still some dew on vines, to prevent shelling, and stored in the barn the same afternoon provided the weather was clear and hot. The hay goes through sweating process after it has been put into the barn, and during period becomes very hot and wet, but if left undisturbed it will out all right, even if stored away partially green.

Owing to the high price of cowpea seed and the large quantity essary for planting, Mr. Walker determined to save the necess seed, if possible. For this purpose he bought a pea thrasher a 12-horsepower gasoline engine to run it. He also found that the could be operated at the same time by a belt from the separator this way the peas could be thrashed and the shredded vines hal the same operation. He now puts all the cowpea crop through machine each year, and what hay and grain is not needed at ho sold.

During the leisure months of the autumn and winter, when there s little that could be done in the fields, the men were put to work thrash the peas and bale the vines. (See fig. 5.)

In 1905 the cowpeas yielded at the rate of 1½ tons of hay and 8 shels of seed per acre, of which a surplus of 20 tons of hay and 100 shels of seed was sold, the hay bringing $15 a ton and the seed $2 a shel.

In 1906, 160 acres were prepared for cowpeas by plowing deep, king, and harrowing. The land was prepared in fields of 20 acres ch, and as each field was ready for planting the drill was started, lowed by the smoothing harrow. The first peas were planted on ril 20 and at intervals until July 20.

In order to determine the proper quantity of seed to sow for the st results, 10 acres in each of the 20-acre fields were planted with ll of the tubes of the drill open, and the other 10 acres with only ach alternate tube open. In this way the drills were 6 inches and foot apart, respectively. In the first instance it required 1 bushel f seed to the acre, and in the latter only half that quantity. The esult was a greater yield of both hay and grain when the smaller uantity of seed was used. It was also found that the later plantngs produced more seed than the earlier ones. Unfortunately, only 20 acres of this crop were saved, as the last 40 acres planted were estroyed by continuous wet weather. However, the remaining 120 cres yielded 116 tons of shredded hay and 1,140 bushels of clean eed. Of this crop 100 tons of hay at $15 a ton and 1,000 bushels f seed at $2.25 a bushel were sold—a total of $3,750 for the surplus owpea crop alone.

IG. 5.—Pea thrasher and baler in operation. With this machine the cowpeas are thrashed and the vines shredded and baled in one operation.

Owing to the very dry season and the scarcity of labor, on acres of cowpeas were planted in 1907. The land was p disked, and harrowed in the usual way and the seed planted in 3 feet 6 inches apart. This was done with a corn planter hav drill attachment, at the rate of a peck of seed to the acre. The were harrowed with a light section harrow when 4 inches high again when about 8 inches high, and were cultivated once af wards with a surface cultivator. This method of planting pr more satisfactory than any heretofore tried. No estimate has made of the yields, as no more of the crop was raised than needed for home use, and only enough grain was thrashed to fur seed for the next year's planting. However, where a stand obtained it is estimated that the peas yielded 15 bushels to acre.

RED CLOVER.

In the early part of September, 1905, 2 acres from which a crop cowpeas had just been harvested were double disked, harr thoroughly, and seeded to red clover at the rate of 15 pounds to acre. This was done with a hand seeder, half of the seed be sown one way and the other half at right angles to the first. field was then lightly harrowed. The stand obtained was very and withstood the winter well. On May 12, 1906, the clover attained a height of about 46 inches and when cut for hay yield tons to the acre. The second crop was allowed to ripen and w then disked in and harrowed. It was noticed that very few nod were present on the roots of this crop.

The seed disked in in this way came up with the first rains in fall, made a good stand, and came through the winter well. April 1, 1906, the clover had attained a height of about 15 inc at which time it was turned under for cotton (see Table IV was now noticed that the roots were abundantly supplied w nodules.

WINTER CROPS.

Crimson clover, bur clover, and vetches have all been grown in small way during the past two years, and in each case the res were very satisfactory. Bur clover, however, seems to adjust it to the new conditions better than the others. Yet crimson cl yielded last year at the rate of more than 3 tons of hay to the ac

In introducing these winter crops it was decided to select a w drained area and to plant the same plot each year until the soil sh become thoroughly inoculated. As was expected, in some cas rather indifferent results were obtained the first year, but in ea case the land was replanted the next autumn, and now not only original plots are becoming inoculated, but the bacteria are spreading out in all directions. At this writing about 60 acres of winter crops have been planted, in which the crops above mentioned, either singly or in combination with others, form the principal part.

Another point worthy of special mention that has become very prominent in this connection is that winter crops in this latitude must be planted early enough in the fall to get a good root system developed before frost comes on; otherwise the crop will not make much growth before spring and is much more likely to be winter-killed. With a well-developed root system winter crops will perform the proper functions for which they are intended in the South; that is, they will make considerable growth during favorable periods in winter and will afford pasturage for stock at times when the ground is not too soft; they will bind the soil and prevent washing; when allowed to grow in the spring they will make sufficient growth to be plowed under as a green manure or make an early crop of hay, whichever is most desirable.

Mr. Walker says:

> Without a doubt the best method to seed clovers and fall grains is to double disk and harrow pea stubble as soon as the pea crop is off the ground. In nearly every case it will be found that this ground will contain a good supply of moisture. Sow clovers broadcast and follow with a board drag to cover seed.

ALFALFA.

Along with the establishment of suitable hay crops, alfalfa was tried in a small way. The first planting was made in 1905 on a well-drained piece of land. Although the seed was carefully inoculated, only about half a stand was obtained. The next year a larger area was put into good condition and planted. This included the area planted in 1905. The results on the new part were the same as in the previous year, while a good stand was obtained on the old portion, yielding three cuttings, the first two cuttings averaging a ton of hay each, and the last half a ton to the acre.

In 1907, four acres adjoining the original plot were carefully prepared for planting and the soil inoculated both by scattering soil from the older tract and by scattering one cutting of the hay from this plot and working it into the soil. The stand in November was very unsatisfactory, despite the fact that every precaution had been taken to insure inoculation, and in order to determine the true cause for this failure a sample of the seed was sent to the Department of Agriculture for test. At the end of a five days' test only 38.4 per cent of the seed germinated. This seed was bought of a reliable firm, yet it was very poor and there is little doubt that this was the principal cause of failure in this case.

CAUSES OF FAILURE IN GROWING LEGUMES.

The main causes of failure in securing a proper stand of legu crops in the South are (1) poor soil, (2) absence of proper nitr- fixing bacteria, and (3) poor seed.

POOR SOIL.

Many of the lands that have been growing cotton and corn the tenant system for years have lost a great deal of their f productiveness. We often hear the term "worn-out soils" a to them. They are worn out only in the sense that the (decaying vegetable matter) in them has been used up by con- clean cultivation, such as cotton and corn usually receive. W humus any soil is robbed of most of its ability to hold available food for crops.

We are accustomed to hear the legumes spoken of as having power, through the nitrogen-fixing bacteria in the nodules on roots, to draw much of their nourishment from the air. Ther however, a period in the growth of these young plants when p of available nutriment must be present in the soil. This period gins when the seedlings have exhausted the stored-up food in the s It ends when enough bacteria have developed to furnish the ne supply of nitrogen from the air. Consequently, if the seed ha sown in soil that has been robbed of its humus there is not en available food for the plant and it dies. Fortunately, there are strong, vigorous-growing legumes that are better adapted to p soils than others, and by growing them first the way can be p pared for the more delicate varieties.

The cowpea is a good example of this kind of crop, yet even it quently gives poor returns on worn-out soils. It will be noticed on this farm the yield of cowpea seed has steadily increased year. This is no doubt due largely to the improved methods of ing adopted, but is it not reasonable to think that part, at leas due to the improved condition of the soil, a fact evidenced b increased yields of cotton and corn? In other words, if the cow will grow on a poor soil, will it not grow better on a better soil?

Then, too, weeds and trash plowed under and allowed to rot greatly. Barnyard manure, if available, is always to be relied u Deep plowing and the turning under of vegetation add humus prevent the soil from "packing" after hard rains, a fault very mon with the old lands of the South.

ABSENCE OF NITROGEN-FIXING BACTERIA.

Poor soils are usually lacking in bacteria suitable to legumes, for reasons. The lack of humus in the soil makes it impossible for th bacteria to find a home in which to obtain food and shelter the

the winter, as they live in the tissues of the decaying leaves, stems, and roots in the soil, and if these are not present they perish. Then, again, on land that has never before grown any of these crops the proper bacteria may never have been present in the soil. Consequently, legumes can not be expected to do their best until bacteria have been supplied in sufficient quantities for the needs of the plants. In the case of the cowpea, on the other hand, we have a crop that has been grown very generally all over the cotton belt for a great many years, and the soils of this region seem to be well supplied with the cowpea bacteria, which no doubt accounts for the ability of this plant to thrive on soils where crops that had never been grown before would fail.

After many years of experimentation it has been demonstrated that it is only a matter of time and patient effort to grow crimson clover, bur clover, the vetches, etc., successfully. The great trouble heretofore has been that farmers who have tried to grow these crops gave up at the end of the first trial, instead of keeping at it for a year or two longer so as to give the proper bacteria a chance to develop. Special attention is called to Mr. Walker's experience in this direction. In the first crop of red clover sown by him very few nodules developed on the roots, but in the second crop they were abundant. The same was true with the other crops, including alfalfa. It is confidently expected that in a very few years, if Mr. Walker continues his present methods, his farm will be so well supplied with the bacteria necessary that all of these crops will be grown with the same certainty of success as cowpeas.

POOR SEED.

The quantity of poor seed on the market at the present time is appalling, and hundreds of failures to procure a stand are directly attributable to inferior seed. In order to prevent the great loss of time and money which results from planting unreliable seed, it is necessary to test all seed bought, or, preferably, it should be tested before it is bought. The seedsman's assurance that it has been tested should not be accepted. Seed should be carefully examined and before purchasing it a sample should be sent to the State agricultural experiment station or to the United States Department of Agriculture for test.

Such tests cost nothing except a few cents for postage. If desired, however, seed can be tested at home by the following simple method:

Method for Testing Seeds at Home.

Count out 100 seeds on a wet blotter or piece of wet flannel and cover them with another piece of the same material; place in a plate or shallow pan and cover with a pane of glass or an inverted plate;

then set on a shelf in the kitchen. At the end of four to examine the seeds and count the number that have germ This number will be the percentage of germinable seeds.

When seed testing is adopted generally by the farmers country, dealers will be compelled to offer only first-class sale.

SURFACE DRAINAGE.

It was stated at the beginning that the farm described bulletin was poorly drained. As tiling or any other form of drainage was too expensive to be considered, it was necessary some form of surface drainage. Fortunately a creek cross portion of the farm and affords an outlet for water from the farm, although the fall is very gradual and water runs off after heavy rains.

The following drainage method has been adopted and is very satisfactory: During the winter months or after a heavy while the water is still standing on the ground, stakes are set lowest places on the farm. When the water is gone and the dry, a plow furrow is run along the line of stakes leading creek. Two furrows are thrown out each way, leaving a deep furrow. Next, a drag, or grader, is used (fig. 6) to throw the soil farther back and leave a gradually sloping bank, so that can drain into the furrow readily at all points along its course.

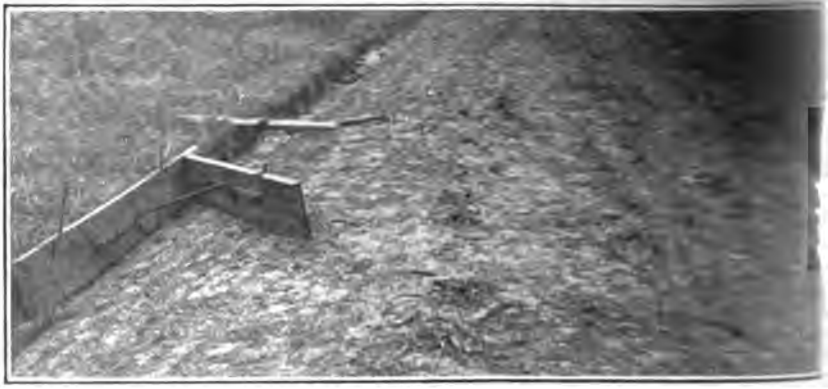


FIG. 6.—Drag, or grader, used in smoothing the sides of a ditch in establishing surface dra is also used, as may be seen in the illustration, in grading up the roads on the farm. nection it will be interesting to note that at the point where the photograph was tak was in exceedingly bad shape until this grading was done. During the winter following as good shape during the entire season as when the photograph was made.

This sloping bank also allows machinery of all kinds to pass the furrow anywhere with very little jar. Great care must be that all obstructions and banks of earth are removed, so as stop the water in any way. (See fig. 7.)

To prevent washing, as soon as the furrow is made and the sides oothed down as described, rye should be sown at once all over the wly opened soil, and with it a mixture of redtop, white clover, and pan clover. The rye will come up first and hold the soil in place til the more permanent grasses have taken root. By keeping the les cut for hay each year, briers and brush will be kept down,

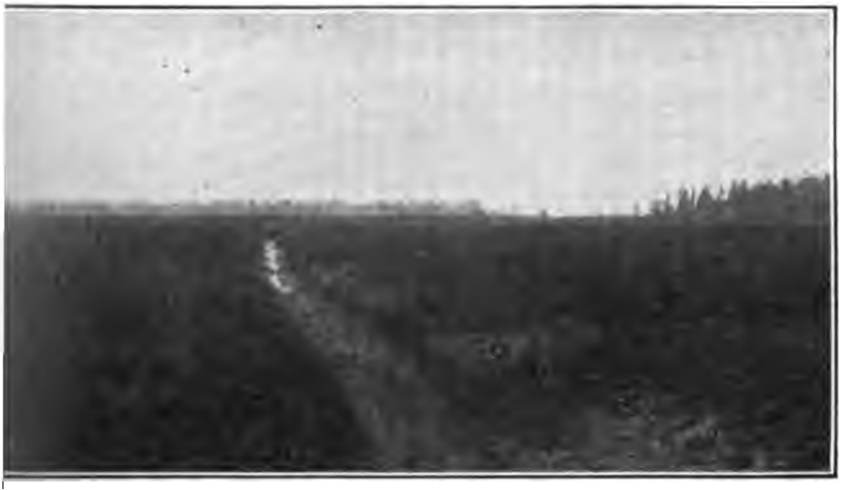


Fig. 7.—A newly opened surface drain with the sides not yet sufficiently smoothed down.

hich will aid greatly in preventing obstructions from accumulating. nless the sides and bottom of the ditch are seeded very quickly, rious washing is likely to occur.

LABOR AND TOOLS.

A noteworthy feature of the work of this farm is the use that has een made of labor-saving machinery and tools. The check-row lanter and 2-horse cultivators have done away with the use of the oe in the cultivation of cotton and corn. The pea thrasher has ade it possible to utilize the cowpea with far greater profit than ould ever be done by the old method of hand picking. The breakng is done with a 16-inch sulky plow, requiring 3 horses and cutting acres a day, and a gang plow requiring 4 horses and cutting 5 acres day. The disking is done with an 8-foot disk harrow and during he past season, on account of the scarcity of labor, a 2-section moothing harrow was hitched behind the disk, requiring 6 horses to ull them. With this arrangement one man can disk and harrow 16 o 20 acres a day. In harrowing corn and pea land a 4-section harow is used, requiring 4 horses, with which one man can harrow 35 o 40 acres a day. By using a drill attachment with a corn planter fast-walking team will plant 20 acres of cowpeas a day.

LIVE STOCK.

MULES.

The principal object of this farm is to raise mules for the m
For this purpose Mr. Walker has stocked it with brood mares,
native to that section and others from the North. These latt
mostly standard bred, and according to Mr. Walker produce
neater in build, cleaner of limb, and more active than tho
native mares. (See figs. 8 and 9.)

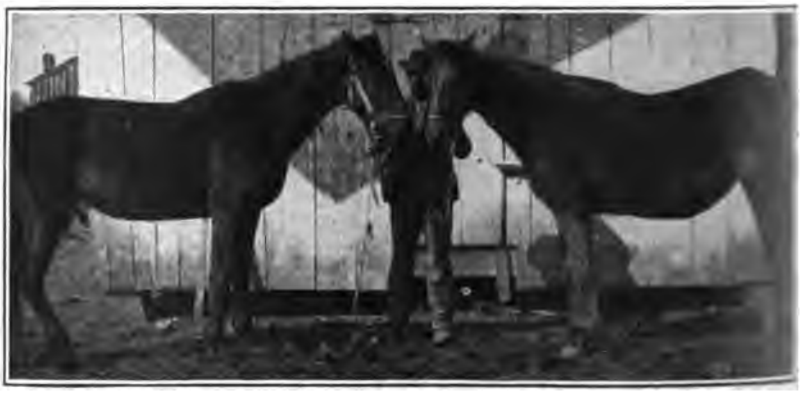


FIG. 8.—A native-bred mare (left) and one of a standard breed (right).

Mr. Walker finds that young northern mares become accli
readily when brought south in the early winter. Old mares, how
especially drafters, do not do well.

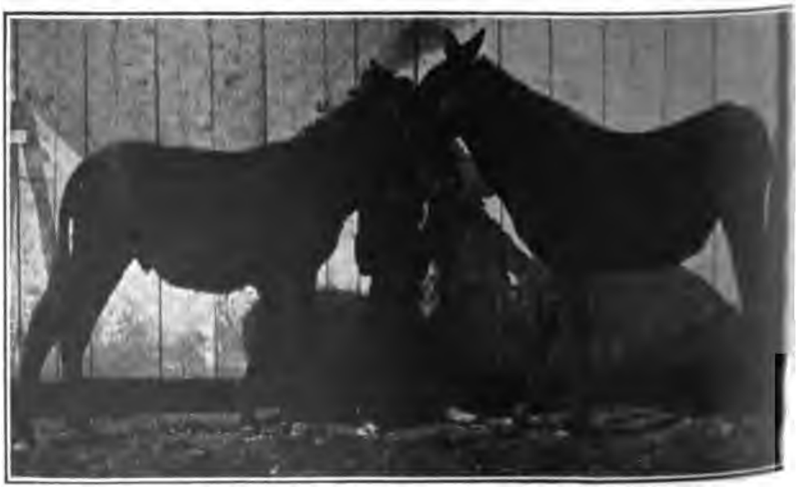


FIG. 9.—Mule colts of the mares shown in figure 8, standing in the same relative positio
mothers.

Only recently the first returns from these mares were re
when four 2-year-old mules and two yearlings sold for $650,
average of $108.33 each.

HOGS.

Incidentally, hogs have been a considerable source of profit during the past two years in using up the waste grain in the corn and cowpea fields and around the pea thrasher. These, together with the cotton, cowpeas, and hay that were sold, have been the principal sources of revenue during this period of restoration.

SUMMARY.

In 1905 the farm described in this bulletin produced one-fourth of a bale of cotton and 15 bushels of corn to the acre.

In 1906, after a crop of cowpeas, it produced one-half of a bale of cotton and 37½ bushels of corn to the acre.

In 1907, after a crop of cowpeas, it produced one-half bale of cotton and 34 bushels of corn to the acre; after cowpeas and 300 pounds of commercial fertilizer, nearly three-fourths of a bale of cotton to the acre; and after cowpeas and clover continuously for two years, one bale of cotton to the acre.

Deep plowing had no detrimental effect on the yields.

Planting corn at different dates tends to safeguard the crop generally against unfavorable seasons and insect pests.

The early planting of corn insures early feed but requires more frequent cultivation.

The late planting of corn produces good seed and winter forage.

Planting cotton and corn in check rows and cultivating both ways saves both seed and labor and on level land does away with chopping and hoeing.

Red clover has proved successful in this latitude as a soil builder and as a hay and seed crop.

Cowpeas have been the most important factor in building up the fertility of the soil.

The pea thrasher has made it possible to utilize the cowpea not only for feed and seed but also as a source of considerable revenue.

Planting cowpeas in rows 3 feet 4 inches apart saves seed and brings greater returns in yields of seed and hay.

Crimson clover, bur clover, and the vetches are successful as winter cover crops when inoculation has been thoroughly established.

Early planting in the autumn is absolutely necessary for the best results with winter crops.

It requires two to three years to thoroughly inoculate worn-out soils with such legumes as have never before been grown on them. The ground should be planted again to the same crop, and a third time, if necessary. Success will follow.

Poor soil, lack of the proper bacteria, and poor seed, either rately or collectively, are responsible for almost every fai legumes.

Shallow surface drains, with the sides and bottom well s insure against water standing on the fields.

Labor-saving tools make possible thorough cultivation with least labor.

FARMERS' BULLETINS.

e following is a list, by number, of the Farmers' Bulletins available for distrion. The bulletins entitled "Experiment Station Work" give in brief the results periments performed by the State experiment stations. Titles of other bulletins self-explanatory. Bulletins in this list will be sent free to any address in the ted States on application to a Senator, Representative, or Delegate in Congress, the Secretary of Agriculture, Washington, D. C. Numbers omitted have been ontinued, being superseded by later bulletins.

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Grape Diseases on the Pacific Coast. Pp. 15.
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Facts About Milk. Pp. 32.
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Insects Affecting the Cotton Plant. Pp. 32.
The Manuring of Cotton. Pp. 16.
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The Dairy Herd. Pp. 30.
Experiment Station Work—I. Pp. 30.
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Bee Keeping. Pp. 48.
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Marketing Farm Produce. Pp. 31.
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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 327.

THE CONSERVATION OF NATURAL RESOURCES.

BY

GIFFORD PINCHOT,
Forester.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1908.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Forest Service,
Washington, D. C., April 16, 1908.

Sir: I have the honor to transmit herewith the manuscript of a paper entitled "The Conservation of Natural Resources." The substance of this paper was delivered as an address by me before the National Geographic Society, in Washington, January 31, 1908. Because of the importance of the subject I desire to recommend the publication of this manuscript as a Farmers' Bulletin.

Very respectfully,

Gifford Pinchot, *Forester.*

Hon. James Wilson,
Secretary of Agriculture.

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HE CONSERVATION OF OUR NATURAL RESOURCES.

A STORY WITH A MORAL.

The conservation of our natural resources is a subject which has ceived little attention in the past; but the facts in the case are so mple, the principles so elementary, and our duty so clear, that they ight be fitly presented in a story like one of the old fairy tales that e all loved when we were boys and girls. Such a story would run ke this:

Once upon a time there was a young man who had been given a reat property in a distant region and who left home to take possesion of it. When he reached his property he first made himself cquainted with it. As he explored it and studied its value he began think how he would make his living out of it. The problem was ot a hard one. He found that his property was wonderfully rich, nd supplied his needs at the cost of far less exertion than he would ave had to make at home, for it was a fair land, well watered, well imbered, abounding in game and fruits, with broad meadows for attle and horses and sheep, and with no small store of rare and urious minerals and an outcrop of excellent coal. Life was easy, and e lived lavishly and joyously, after the initial hard work of moving n and building his house and raising his first crops was over. He had far more land than he could use, far more game, and what he lacked he was able to buy from home with furs, with timber, with minerals, and with the surplus of his crops.

By and by he saw and liked a girl and finally married her. Together they prospered on the property, which seemed too rich to make it necessary for them to trouble about the future. Game was still plenty, though less so than at first; the timber, though growing less, was still abundant enough to last longer than they could hope to live; by breaking new land they could always count on marvelous crops; the coal was a little harder to get at, but still close to the surface, and besides the man only dug out the easiest to reach, and when the earth began to cave in he merely started again at a new place. His stock, grazing on the meadows, had trampled out some of the grass, but there was still no lack. That some day strangers would possess their property when they had done with it, and would find it somewhat run down, did not trouble these two good people at all.

But children came to them with the years, and by and by children began to grow up. Then the point of view of the ma his wife changed. They wanted to see their sons and daughters p vided for and settled on this property of theirs, and they began to that what was enough and to spare for them would not supp their children in the same comfort unless they themselves used it better foresight. Through thinking of their children they wer to live more in the future.

They looked forward and said to themselves: “Not only mu meet our own needs from this property, but we must see to it our children come in for their fair share of it; so that after a w the happiness we have had here may be carried on to them.” the family established itself. The man became respected, an children grew up healthy and happy around him; and when i fullness of time he passed away and his children took the pla which he had stood, because of his foresight and care they en the same kind of prosperity he had enjoyed.

It is a perfectly simple story; we all of us can name scores of who have done this same thing. The men and the women who d are not famous, are not regarded as remarkable in any way: t are simply good, everyday, average citizens, who are carrying the duties of the average citizen.

WHAT WE HAVE DONE WITH OUR NATIONAL RESOURCES

Once upon a time there was a young nation which left its h and moved on to a new continent. As soon as the people formed the first settlements began to examine the value and cond of this new continent, they found it marvelously rich in every p resource. The forests were so vast that, in the early days, they not a blessing, but a hindrance. The soil was so rich and there so much of it that they were able at first only to cultivate the edg their great property. It was quite plain to these people in the times that, however much land they might cover, however much t might waste, there was always going to be plenty left. As time on they discovered greater and greater resources. They found derfully rich deposits of metallic ore; great oil and gas field vast stretches of the richest bituminous and anthracite coal la noble rivers flowing through broad expanses of meadow; rich allu prairies; great plains covered with countless herds of buffalo antelope; mountains filled with minerals; and everywhere opport ties richer than any nation had ever found elsewhere before.

They entered into this vast possession and began to use it. T did not need to think much about how they used their coal, or or timber, or water—they would last—and they began to encr on the supply with freedom and in confidence that there would always be plenty. The only word with which they described what they had, when they talked about it, was the word "inexhaustible."

Let us see for a moment what the course of development of this young nation was. First of all they needed men and women to settle on the land and bring up children and have a stake in the country. That was absolutely necessary before there could develop the great nation which some of them saw ahead. As the population spread there arose a need that great systems of transportation should be built to knit the country together and provide for the interchange of its products. These railroads called for iron, coal, and timber in great quantities. Then began an unprecedented demand upon the forests. They could not build those transcontinental railroad lines without millions upon millions of railroad ties cut from the forests of the country; and they could not mine the iron and coal except as the forests gave them the means of timbering their mines, transporting the ore, and disposing of the finished product. The whole civilization which they built up was conditioned on iron, coal, and timber. As they developed their continent, richer than any other, from the east coast to the west, new resources became revealed to them, new interests took possession of them, and they used the old resources in new ways. In the East, the rivers meant to them only means of transportation; in the West they began to see that the rivers meant first of all crops; that they must put the rivers on the land by irrigation before they could grow wheat, alfalfa, fruits, sugar beets, and other crops that make the West rich. They found that to feed the vast population which had grown up in the East they must have the vast ranges of the West to grow meat. They found that the resources of soil and water which produced the wheat, the cotton, and the meat—of iron and coal, and of timber, together made up the working capital of a great nation, and that the nation could not grow unless it had all of these things. In taking possession of them our nation used them with greater effectiveness, greater energy and enterprise, than any other nation had ever shown before. Nothing like our growth, nothing like our wealth, nothing like the average happiness of our people can be found elsewhere; and the fundamental reason for this is, on the one side, the vast natural resources which we had at hand, and on the other side the character, ability, and power of our people.

Now what have we done with these resources which have made us great, and what is the present condition in which this marvelously vigorous nation of ours finds itself? The keynote of our times is "development." Every man from New York to San Francisco looks to the development of the natural resources to produce the advantages

and the opportunities he wants for his neighbors and his fr
Anyone who questions the wisdom of any of the methods we ar
in bringing that development to pass, because he believes we ar
ing mistakes that will be expensive later on, is in danger of bein
sidered an enemy to prosperity. He is in danger of having it th
of him that he does not take pride in our great achievements,
he is not a very good American. But in reality it is no sign th
man lacks pride in the United States and the wonderful thing
people have done in developing this great country because he
to see that development go on indefinitely. On the contrary,
patriotism and pride in our country make it the first of all duti
see that our nation shall continue to prosper. In sober truth, we
brought ourselves into a condition in which the very serious dim
tion of some of our most necessary resources is upon us.

WHAT WE FACE.

Forest resources.—A third of the land surface of this country w
originally covered with what were, all in all, the most magni
forests of the globe—a million square miles of timberland. In
short time, as time counts in the life of nations, we have been her
have all but reached the end of these forests. We thought it u
portant until lately that we have been destroying by fire as
timber as we have used. But we have now reached the point w
the growth of our forests is but one-third of the annual cut, w
we have in store timber enough for only twenty or thirty year
our present rate of use. This wonderful development, which w
have been impossible without the cutting of the forests, has bro
us where we really face their exhaustion within the present ge
tion. And we use five or six times as much timber per capita
the European nations. A timber famine will touch every m
woman, and child in all the land; it will affect the daily life of
one of us; and yet without consideration, without forecast, and w
out foresight, we have placed ourselves, not deliberately but thou
lessly, in a position where a timber famine is one of the inevit
events of our near future.

Canada can not supply us, for she will need her timber her
Siberia can not supply us, for the timber is too far from water tra
portation. South America can not supply us, because the timber
that vast continent are of a different character from those we
and ill adapted to our need. We must suffer because we have c
lessly wasted the forest, this great fundamental condition of
It is impossible to repair the damage in time to escape much suffer
although not too late to work hard to reduce it as much as we c

inerals, oil, and natural gas.—But forests only begin the story of impaired capital. Our anthracite coals are said to be in danger xhaustion in fifty years, and our bituminous coals in the begin- g of the next century; some of our older oil fields are already ex- sted; the natural gas has been wasted. burning night and day in y towns until the supply has failed. Our iron deposits grow less year. Our ranges in the West, from which we first drove the falo to cover them again with cattle and sheep, are capable of porting but about one-half what they could under intelligent nagement, and the price of beef is raised accordingly. Nearly ry one of our wonderful resources we have used without reason- e foresight or reasonable care, and as each becomes exhausted a vier burden of hardship will be laid upon us as a people.

ow what is our remedy? The remedy is the perfectly simple of common sense applied to national affairs as common sense is lied to personal affairs. This is no abstruse or difficult question. have hitherto as a nation taken the same course as did at first young man who came into possession of his new property. It is e for a change.

It is true that some natural resources renew themselves while others not. Our mineral resources once gone are gone forever. It may pear, therefore, at first thought that conservation does not apply them since they can be used only once. But this is far from being fact. Methods of coal mining, for instance, have been permitted this country which take out on the average but half of the coal. en in a short time the roof sinks in on the other half, which reafter can never be mined. Oil and natural gas also have been d are being exploited with great waste and as though there never ld be an end to them. The forests we can replace at great cost d with an interval of suffering.

Soil waste.—The soil which is washed from the surface of our rms every year to the amount of a billion tons, making, with the rther loss of fertilizing elements carried away in solution, the aviest tax the farmer has to pay, may in the course of centuries be placed by the chemical disintegration of the rock; but it is de- ledly wiser to keep what we have by careful methods of cultivation. e may very profitably stop putting our farms into our streams, to dug out at great expense through river and harbor appropriations. rtile soil is not wanted in the bed of a stream, and it is wanted on e surface of the farms and the forest-covered slopes of the moun- ins. Yet we spend millions upon millions of dollars every year moving from our rivers what ought never to have got into them.

WASTE THROUGH PIECEMEAL PLANNING.

Besides exhausting the unrenewable and impairing the renewable sources, we have left unused vast resources which are capable of adding enormously to the wealth of the country. Our strea been used in the West mainly for irrigation and in the East for navigation. It has not occurred to us that a stream is n not merely for one, but for a considerable number of uses: th uses are not mutually exclusive, and that to obtain the full b of what the stream can do for us we should plan to develop uses together. For example, when the National Government dams for navigation on streams, it has often disregarded the p use, for power, of the water that flows over those dams. En say that many hundred thousand horsepower are going to wast Government dams in this way. Since a fair price for power, it is in demand, is from $20 to $80 per horsepower annually, be seen that the Government has here, developed, yet lying resource capable, under the right conditions, of adding enor to the national wealth. So also in developing the western st for irrigation, in many places irrigation and power might b to go hand in hand.

DANGER OF MONOPOLY.

If the public does not see to it that the control of water p kept in the hands of the public, we are certain in the near f find ourselves in the grip of those who will be able to control, monopoly absolutely without parallel in the past, the daily li our people. Let us suppose a man in a western town, in a r without coal, rising on a cold morning, a few years hence, invention and enterprise have brought to pass the things whi can already foresee as coming in the application of electricity. turns on the electric light made from water power; his breakf cooked on an electric stove heated by the power of the stream morning newspaper is printed on a press moved by electricity the streams; he goes to his office in a trolley car moved by ele from the same source. The desk upon which he writes his letter merchandise which he sells, the crops which he raises, will hav brought to him or will be taken to market from him in a frei moved by electricity. His wife will run her sewing machine churn, and factories will turn their shafts and wheels, by the power. In every activity of his life that man and his family a neighbors will have to pay toll to those who have been able to m lize the great motive power of electricity made from water pow that monopoly is allowed to become established. Never before history of this or any other free country has there existed the p bility of such intimate daily friction between a monopoly and th of the average citizen.

It has not yet occurred to many of our people that this grea should be conserved for the use of the public. We have regar thing to be given away to any man who would take it. We have ried over our point of view derived from the early conditions when vas a God-send to have a man come into the country to develop ver and we were willing to give him anything to induce him to e. We have carried over that point of view into a time when the ad of a monopoly of this kind ought to be in the mind of the aver- man everywhere. That is an instance of a resource neglected m the point of view of the public.

A NEW POINT OF VIEW.

But this is a time to consider not one resource but all resources ether. Already here and there small associations of citizens have ome possessed of certain facts, and have begun to work at cer- n sides of what is fundamentally one great problem. We have drainage association, whose object is to make habitable millions on millions of acres, now lying waste in swamps all over the coun- , but capable of supporting in comfort millions of people. We ve forestry associations, waterway associations, irrigation associa- ns, associations of many kinds touching this problem of conserva- n at different points, each endeavoring to benefit the common weal ng its own line, but each interested only in its own particular ce of the work and unaware that it is attacking the outside, not heart of the problem. Now a greater thing is opening out in e sight of the people. This problem of the conservation of natural sources is a single question. Each of these various bodies that ve been working at different phases of it must come together on nservation as a common platform. By the joining of these units shall have a mass of intelligent, interested, public-spirited citi- ns anxious to adopt a new point of view about this country of ours. That is the crux of the whole matter—a new point of view about r country. We have been so busy getting rich, developing and owing, so proud of our growth, that we have let things go on until me intolerable abuse has driven us to immediate action. It is time at we put an end to this kind of opportunism, of mere drifting. e must take the point of view taken by the average prudent busi- ss man, or man in any walk of life who has property and is terested in it. What the average man does in his own affairs is to resee trouble and avoid it if he can. What this nation of ours is ing in this fundamental matter of natural resources is to run right to trouble head down and eyes shut, and so make that trouble in- itable before taking any step to prevent it. But it should not take ng to reach the stage of national thought where we shall deliber- tely plan to avoid the difficulties which can be foreseen, if only we n bring together all who have already begun to concern themselves ith one or another aspect of the conservation problem.

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THE PROBLEM BEFORE US.

This nation has, on the continent of North America, three and a half million square miles. What shall we do with it? How can we make ourselves and our children happiest, most vigorous and efficient, and our civilization the highest and most influential, as we use that splendid heritage? Ought not the nation to undertake to answer that question in the spirit of wisdom, prudence, and foresight? There is reason to think we are on the verge of doing this very thing. We are on the verge of saying to ourselves: "Let us do the best we can with our natural resources; let us find out what we have, how they can best be used, how they can best be conserved. Above all, let us have clearly in mind the great and fundamental fact that this nation will not end in the year 1950, or a hundred years after that, or five hundred years after that; that we are just beginning a national history the end of which we can not see, since we are still young." In truth we are at a critical point in that history. As President Roosevelt has said, we are at the turning of the ways. We may pass on along the line we have been following, exhaust our natural resources, continue to let the future take care of itself; or we may do the simple, obvious, common-sense thing in the interest of the nation, just as each of us does in his own personal affairs.

On the way in which we decide to handle this great possession which has been given us, on the turning which we take now, hangs the welfare of those who are to come after us. Whatever success we may have in any other line of national endeavor, whether we regulate trusts properly, whether we control our great public service corporations as we should, whether capital and labor adjust their relations in the best manner or not—whatever we may do with all these and other such questions, behind and below them all is this fundamental problem, Are we going to protect our springs of prosperity, our sources of well-being, our raw material of industry and commerce, and employer of capital and labor combined; or are we going to dissipate them? According as we accept or ignore our responsibility as trustees of the nation's welfare, our children and our children's children for uncounted generations will call us blessed, or will lay their suffering at our doors. We shall decide whether their lives, on the average, are to be lived in a flourishing country, full of all that helps to make men comfortable, happy, strong, and effective, or whether their lives are to be lived in a country like the miserable outworn regions of the earth which other nations before us have possessed without foresight and turned into hopeless deserts. We are no more exempt from the operation of natural laws than are the people of any other part of the world. When the facts are squarely before us, when the magnitude of the interests at stake is clearly before our people it will surely be decided aright.

FARMERS' BULLETINS.

The following is a list, by number, of the Farmers' Bulletins available for distribution. The bulletins entitled "Experiment Station Work" give in brief the results of experiments performed by the State experiment stations. Titles of other bulletins are self-explanatory. Bulletins in this list will be sent free to any address in the United States on application to a Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C. Numbers omitted have been discontinued, being superseded by later bulletins.

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24. Hog Cholera and Swine Plague. Pp. 16.
27. Flax for Seed and Fiber. Pp. 16.
28. Weeds: And How to Kill Them. Pp. 30.
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30. Grape Diseases on the Pacific Coast. Pp. 15.
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54. Some Common Birds. Pp. 48.
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SILVER FOX FARMING.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., May 28, 19

Sir: I have the honor to transmit herewith a report on the rearing of silver foxes. As civilization encroaches on the breeding grounds of wild animals the supply of fur steadily diminishes and the price correspondingly advances. If furs as articles of use and adornment are not soon to disappear from general use, methods must be devised for raising fur-bearing animals in confinement. This subject is now being investigated by the Biological Survey. The present bulletin furnishes information as to the possibilities of the propagation silver, or silver-black, foxes and the best methods of conducting the business. The silver-black fox is one of the highest priced of fur-bearers, and hence offers a tempting field for experiment. The business of raising this animal is believed to promise fair if not large returns for skill, experience, and the investment of moderate capital.

I recommend that this report be published in the Farmers' Bulletin series.

Respectfully,

C. Hart Merriam,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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SILVER FOX FARMING.

INTRODUCTION.

Of all the products derived from wild animals, furs are the most useful and valuable. Indispensable to primitive man, they are scarcely less important to the most civilized, for in warmth, beauty, and durability no manufactured fabrics excel them. But expanding civilization is steadily diminishing the supply of furs, both by increasing the demand and by encroaching upon the territory in which they are produced. Many furs, like ivory, whalebone, and other natural commodities, already are so scarce that the demand for them is met largely by the substitution of inferior products. Activity in the pursuit of fur-bearing animals and development of system in handling and marketing the furs have reached a degree scarcely to be surpassed. Therefore the growing and world-wide demand for furs of high quality can be met only by increasing the number of the animals producing them. This at once suggests that fur bearers may be propagated in confinement, and that by this means an important industry may be developed. The idea is not new, for the domestication of fur-bearing animals has been the subject of considerable thought and experiment in the past. Most of the early enterprises were devoted to the smaller and less valuable animals, as skunks and minks, and seldom advanced beyond theoretical or experimental stages; but results of considerable importance have been obtained recently with the blue fox in Alaska and with the silver fox in eastern North America.

The Biological Survey as yet has not investigated the Alaska blue fox industry, but a study of silver fox raising has been made, in the course of which a number of persons engaged in the business were visited and their methods examined.[a] From this study it appears that although many experiments have failed, a few have succeeded to an extent indicating important possibilities for the future. It may be stated, however, that success is not due to following any set of rules, since much depends upon the personal fitness of the one conducting the undertaking. It is to be remembered also that as a business fox raising is still in the experimental stage, and that even the most successful breeders are subject to a percentage of failure.

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[a] At the request of many of them the names of these fox breeders are withheld, but thanks are due to all of them for the facilities and information which they courteously furnished.

THE SILVER FOX.

The name "silver fox," as commonly used by furriers, includes the dark phases of the ordinary red fox, variously called silver, silver-gray, silver-black, or black. The animal is the common fox (*Vulpes fulvus*) of northern North America, the crafty Reynard of the books, closely allied to the European fox. It should not be confused with the gray fox, or tree fox, of the southern part of the United States, a very different animal, the fur of which has comparatively little value. Naturalists distinguish several species and subspecies, the characters of which are not important in the present connection. The color of the red fox of the northeastern States and of its allies of the colder parts of North America varies from red to black, and these extremes, with the gradations between them, form four more or less distinct phases, respectively known as red, cross (or patch), silver, and black. In the red phase the animal is entirely rich fulvous, except restricted black markings on the feet and ears, a white area at the end of the tail, and certain white-tipped hairs on the back and rump. From this phase to the next the black increases in extent until, in the typical cross fox, the black predominates on the feet, legs, and underparts, while fulvous overlaying black covers most of the head, shoulders, and back. A gradual increase of the black and elimination of the fulvous or its replacement by white brings us to the next phase, the silver (or silver-gray), in which no fulvous appears, the entire pelage being dark at the base and heavily or lightly overlain with grayish white. Silver foxes vary from those in which the color is entirely grizzled to those in which it is entirely black, except a few white-tipped hairs on the back and rump. Finally, in the black phase, the white is absent from all parts except the tip of the tail, which is white in all phases. The red phase is much more abundant than the others, but the three interbreed freely, and wherever one occurs occasional examples of the others also may be expected. In general the cross fox is fairly common, the silver-gray is comparatively scarce, and the pure black is excessively rare. The prices usually paid for skins of the different phases vary according to the relative scarcity of the animals. Thus red fox skins command only a moderate price, cross foxes are somewhat higher, silver foxes are several times higher, and pure black skins are exceedingly valuable, being higher priced than any other fur except sea otter.[a]

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[a] The following prices are quoted on fox skins (northeastern) in the Fur Trade Review for January, 1908: Red fox, $1.50 to $3.50; cross fox, $4 to $ silver fox, $50 to $250. These prices are low, and indicate only the relative values of the three color phases. Much higher prices are frequently paid for skins of extra quality, especially for high grade silver fox skins.

Since the animals are essentially alike in habits and in all respects except color, it is evident that silver foxes can be bred as easily as red ones and at a much greater profit, provided they breed true to color. Therefore, although some attention has been given to raising red and cross foxes, efforts to breed the more valuable silvers have been more persistent.

HISTORY OF SILVER FOX BREEDING.

Foxes, especially red foxes, have been kept alive in zoological collections and by private individuals since early historic times. Owing to the value of its fur, however, the silver fox seldom has been confined longer than necessary for it to attain marketable condition. The persons most likely to obtain the live animals have been farmers and woodsmen, to whom immediate returns were of such importance that few cared to risk experimentation for the sake of future profits. Only in recent years and in most cases only after experience with the less valuable red foxes have serious attempts been made to raise silver foxes. Of some twenty parties known to have engaged in breeding them, one began fifteen years ago and another eight years ago, while all the others undertook the business within the last five years. Those who have persevered in spite of early failures have in the end attained considerable success. Some have become discouraged and have discontinued after a few years, while others are now just beginning and their experience is too slight to be of much value in determining the practicability of the business. Most of them are men of small means living in sparsely settled regions. Their original stock has been obtained chiefly by taking the young from the dens of wild foxes. In some cases small stock companies have been formed and considerable sums of money invested in land, equipment, and breeding stock. For reasons explained later (p. 18), most of these companies have failed.

Thus far, the breeding of silver foxes has been carried on chiefly in the State of Maine and in the Canadian Maritime Provinces—New Brunswick, Nova Scotia, and Prince Edward Island. It has been undertaken to some extent also in Michigan, Alaska, Labrador, and Newfoundland.

AREA SUITED FOR FOX FARMING.

The natural habitat of red, cross, and silver foxes includes the greater part of northern North America, from the central United States northward to and including the border of the treeless tundra. The red phase inhabits nearly all this region, but the silver phase, although known from most parts of it, is very irregularly distributed. In general it is much more common in northern localities than in southern, but many parts of the north where red foxes are abundant produce silvers only rarely. From the reports of wholesale fur buyers, it is learned that many silver fox skins of high quality are secured from Newfoundland and from the Height of Land, between Quebec and the peninsula of Labrador. Considerable numbers come also from Alaska and the Canadian Northwest.

It is, of course, well known that pelts of all fur-bearing animals are more valuable when produced in northern localities. Furriers learn from experience that certain localities are not too far south to produce valuable furs, but the conclusions they are able to form are only of very general application. The ordinary individual, however, is seldom able to profit by the experience of furriers and, especially if he chances to live in a region from which fur-bearing animals have been extirpated, he is unable to judge whether or not his own locality is favorably situated for producing foxes with valuable pelts. Fortunately, a reliable guide to all such matters is furnished by the maps of the life zones of the United States. These zones are transcontinental belts, throughout which the animal and plant life are relatively uniform in character. To determine the areas suitable for fox farming, therefore, it is necessary only to learn which zones include localities where foxes are known to produce superior fur. The records of the Biological Survey show that such localities occur only north of the southern boundary of the Canadian zone. This boundary, as shown on accompanying map (fig. 1), crosses the States of Maine, New Hampshire, Vermont, Michigan, Wisconsin, Minnesota, and North

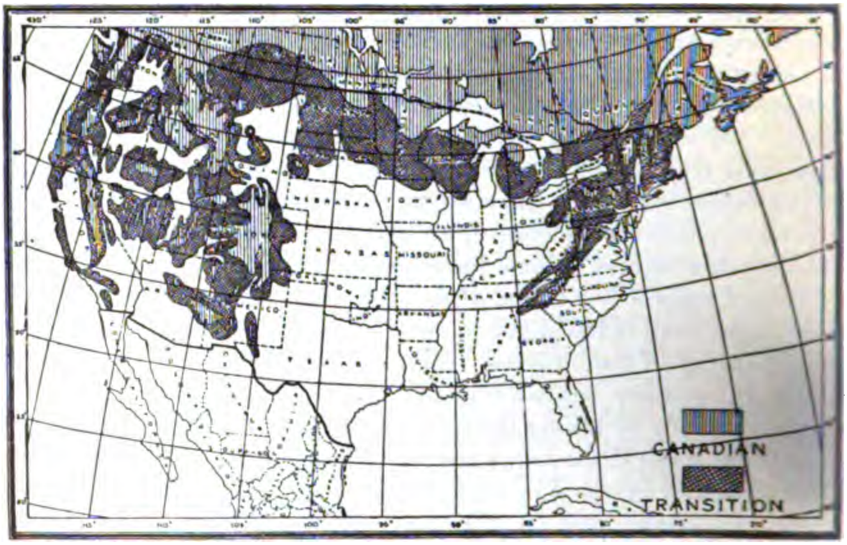

FIG. 1.—Map of life zones in which fox farming is feasible in the United States, showing the Canadian zone where conditions are excellent, and the Transition zone, in parts of which conditions are favorable.

akota, and extends southward along the mountains in New York, ennsylvania, West Virginia, and in all the States of the Rocky ountain region and westward. South of this line, in the transition ne, foxes having a fair quality of fur may be raised, but the best e obtained only in the Canadian and more northern zones.

CHARACTER OF LOCATION AND SPACE REQUIRED.

Having decided upon the latitude and climate best for fox raising, is important next to consider the character of the exact location to selected. It is possible to closely approximate the conditions unr which wild foxes live, but this is by no means essential; indeed, hether it is desirable even is somewhat doubtful. If the inclosures e too large, particularly if they afford a variety of conditions, the xes may remain so wild as to be unmanageable. On the other nd, if the enterprise is conducted in limited quarters in a city, or en in a small village, where the foxes are often disturbed by visitors, ey become restless and suspicious and do not breed well. The best onditions, therefore, are neither exactly natural nor yet too artificial. oxes require very little space and thrive in inclosures not more than 0 feet square. These may be but a few rods from a farmhouse fig. 2), or, if visitors are excluded, in a quiet place on the outskirts f a village. A total space of 5 acres is ample for extensive operaions, and it is not likely that more than 2 acres will be needed for ny except a large and long-established business. A half acre will ccommodate about 6 pairs of foxes, which is quite as many as a eginner should attempt to handle. The selection of ground may epend upon circumstances, but effort should be made to include few trees or small shrubs. These afford shade and a feeling of eclusion and security to the animals. Perfectly open ground has

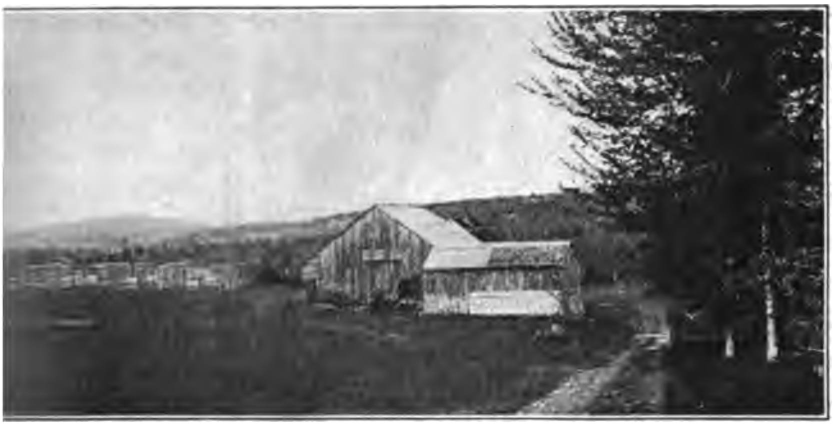

FIG. 2.—Fox yards on open ground near a farmhouse.

been used with fair success, and in other cases yards have bee ated in thick woods (fig. 3). Neither extreme is to be desir many trees are better than none at all. For the sake of clea sandy soil should be selected wherever possible.

The fox farm of exaggerated newspaper account usually is re sented as occupying a lonely island or a vast inclosure of wild and too often beginners are led to believe that such places ar sential. This is not the case, for, although an ordinary back is not quite sufficient, but little more is required. Islands have advantages and apparently are suited to the requirements of foxes in Alaska; but silver foxes need close personal attention. can better be in restricted sures.

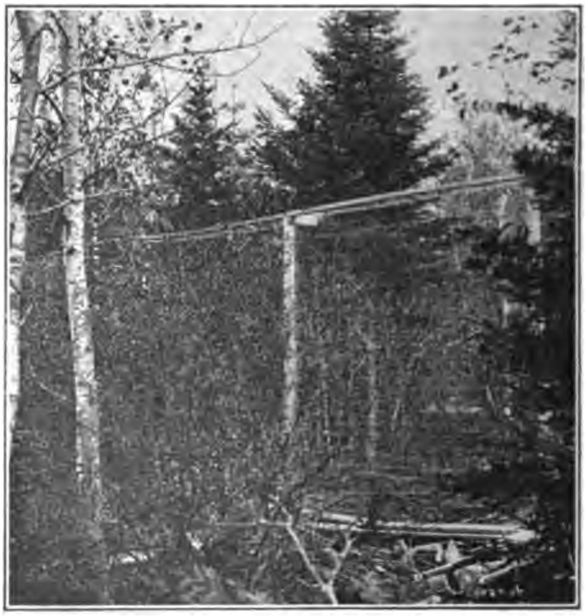

FIG. 3.—Fox yards in thick woods.

INCLOSURES AN EQUIPMENT

Inclosures foxes are with some of many varieties woven-wire ing. No. 16 vanized wire strong enough not so durable No. 14. The should be greater than inch, for foxes are able wriggle through opening 3 in square. The fencing should be about 10 feet high and sunk into ground 2 feet, while at the top 2 feet should be allowed for an in overhang to prevent the animals from climbing out. The sunken may be turned in 1 foot or more, and flat stones may be laid at edge to prevent escape by digging. Experience shows that this caution is rather more than is necessary, for since the foxes tr escape by digging only at the edge of the wire, sufficient secur obtained by merely sinking the wire directly into the ground. use of stones, however, is usually but little additional expense. way they are laid is well shown in figure 4. The overhanging zontal wire is easily adjusted along the top of the fence by m

F cross pieces on the posts. This is essential, for foxes are good imbers, and in winter snow often greatly reduces the distance to ie top of the fence. The arrangement of subdivisions will necesarily depend somewhat upon circumstances, but the general plan iould in most cases conform to that shown in the accompanying iagram (fig. 5). Here a wide outer court is provided, separating ie smaller inclosures in which the foxes are actually kept from the nfenced area possibly open to the public. The court shown in the diaram is only 40 feet wide, but it might well be much wider, since its bject is not so much to give additional security as to prevent curious isitors or stray domestic animals from annoying the foxes. As the oxes may be annoyed merely by seeing persons or animals at a disance, it is best to ave a wide outer ourt, containing, f possible, bushes nd trees. This uter court may be ept locked and he inner incloures visited only y regular keepers, o whom the foxes re accustomed. If he locality be sufficiently quiet the uter court may be arrow or, in some ases no doubt it nay safely be omitted, but the imporance of preventng annoyance of the animals can scarcely be overestimated. Often he inclosures may be situated within a fenced pasture. Other means for obtaining seclusion also may be employed, as the training of edges or the building of solid board fences about 6 feet high imnediately outside the wire fences.

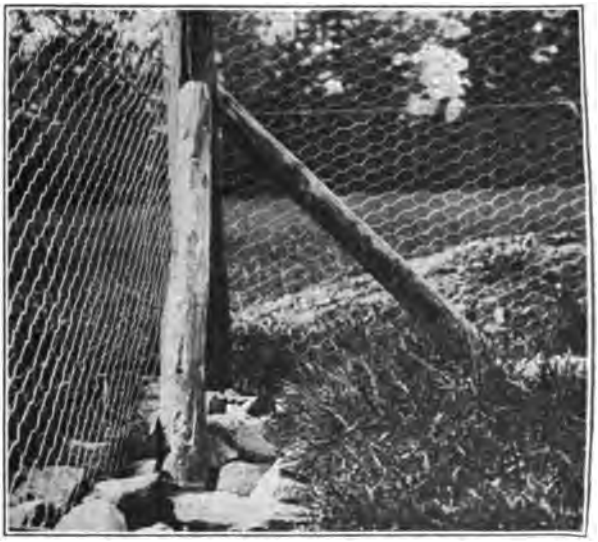

FIG. 4.—Corner of fox yard showing stones to prevent escape by digging.

The inner inclosures are of two kinds, most of them small and designed for single animals or pairs, but one or more are somewhat larger and intended to accommodate a number of foxes at one time. Every compartment should be provided with doors so arranged that animals may be transferred readily. The beginner with only one pair of foxes may start with two of the small compartments and gradually add others as needed, meanwhile keeping in mind some general plan insuring a systematic and convenient whole. The small compartments should be at least 30 feet square. Those shown in the diagram are 30 by 40 feet and the larger runs 75 by 40 feet. Passageways giving free access to all the compartments should be 4 to 6 feet wide. Each compartment should contain a small house or shelter box, for, although the foxes often dig natural dens in the ground, they usually accustom themselves readily to artificial shelters. A common form of these is much like a dog kennel and about the same size (see fig. 8). They are ordinarily made 4 or 5 feet square and 2 or 3 feet high, with an entrance about 6 inches square. A small, hinged trapdoor 8 inches square, giving the keeper access to the inside, may be provided on the back of the house, but this is seldom needed, and its absence removes the temptation to disturb a parent fox at a critical time. Several other forms also are used, especially some contrived with reference to the exclusion of light. These may be made of boxes or barrels to which are attached closed passages about 2 feet long, with a single or a double elbow at the end (see figs. 6 and 7). These furnish retreats more nearly like a natural fox

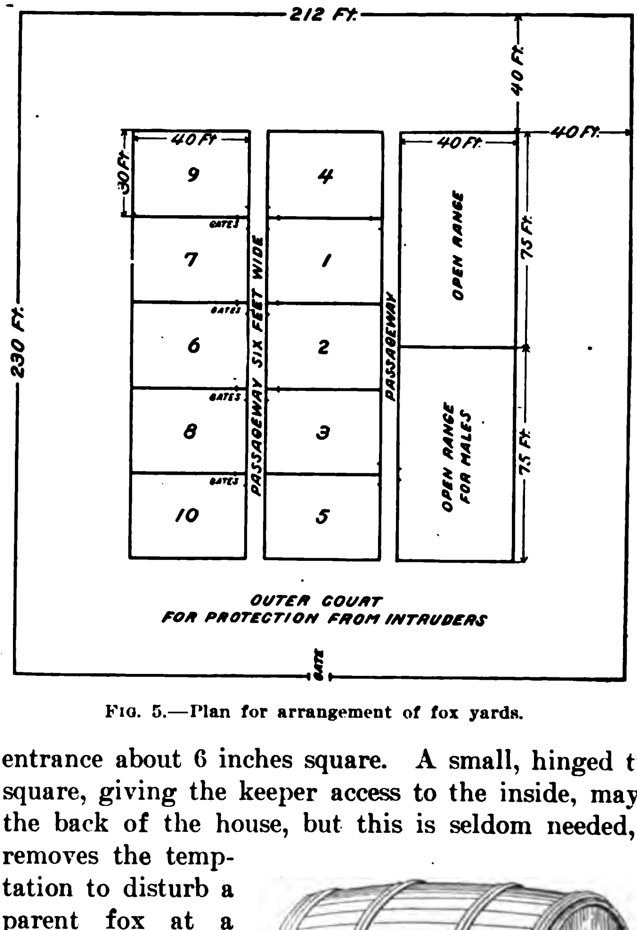

FIG. 5.—Plan for arrangement of fox yards.

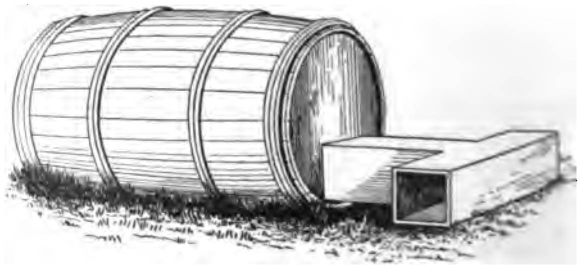

FIG. 6.—Barrel shelter for female and young.

than the kennels, but it is doubtful if they are superior. No ting material is needed inside the boxes, as the old foxes either without or provide themselves from refuse in their inclosure.

FOOD.

Vild foxes eat a great variety of food, including mice, rabbits, ds, and insects, such as grasshoppers, crickets, and beetles. At tain seasons large quantities of berries are eaten. Meat, therefore, only part of their natural diet. Many fox breeders, failing to ognize this fact, have fed meat largely or exclusively. Although s is not always followed by bad results, it is much better to supply foxes with a mixed diet, including, besides meat, such food as ead, milk, table scraps, or manufactured dog biscuits, all of which relished. Indeed, foxes, like dogs, are almost omnivorous, and ere is less danger in any particular kind of food than in too large antities at irregular intervals. Overfeeding is a very common ouble and pro-uces fat, sluggish imals that do t breed well. he normal weight a healthy fox from 6 to 9 ounds; so animals weighing ore than 10 ounds are too fat. hen excessively t they may weigh much as 16 pounds. Overfat animals are sometimes produced by eeping a number in one inclosure, making it possible for the boldest r tamest to get more than his share of food.

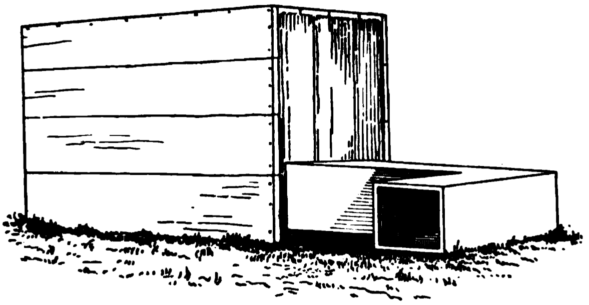

FIG. 7.—Box shelter for female and young.

It is always to be remembered that foxes in confinement require s much care as other animals. But it is a strange fact that the exerienced stock raiser, who knows full well what disastrous results ollow when his horses or cattle get free access to the grain bin, will nhesitatingly throw a whole carcass to his foxes and let them gorge. ince this does not kill them at once, or make them visibly sick, and ince they are supposed to feed in this way in the wild state, he sees othing wrong in it, especially as it saves the trouble of daily attendnce. If for no other reason, a regular daily ration is preferable o irregular feeding because it necessitates a more constant and intinate relation between the keeper and his charge. It is a good plan, owever, to give them bones with little meat on them now and then, upon which they may gnaw indefinitely. Occasionally they may be regaled with tidbits consisting of small wild mammals, as woodchucks, rats, mice, and other animals likely to be captur the farm. Fresh drinking water, of course, should be suppli larly. If a spring or other natural water supply can be within the yards much labor is saved.

A fair daily allowance for each fox is one-fourth of a po meat and a small handful of miscellaneous scraps. One of th successful breeders feeds a quarter of a pound of meat and a of skim milk daily. Another varies the meat diet with a hoecake made of corn meal and sour milk. The meat used i or mutton in the form of butcher's scraps, unsalable parts, like, or, most commonly, horse meat procured especially for th pose. Horse meat is very satisfactory food for foxes and esp commends itself on account of its cheapness. In all rural di it is a very simple matter to procure a worn-out but perfectly h horse, and after slaughtering it to keep the carcass on ice, fur a supply of meat for months. When located on the seacoa fishing settlements fox raisers supply fish, lobsters, and oth foods to their foxes at little or no cost and find them satisfa The expense of feeding is thus comparatively small. Accord an estimate of one of the most experienced fox breeders, wh butcher's meat and skim milk, the cost of feeding one fox, everything is purchased, is 1 cent per day. In actual practice ever, the cost in his case was much less, since he was able to the scraps from his own table and to obtain much other mat from his neighbors.

BREEDING.

Foxes breed only once a year, and the mating or rutting s includes the months of February and March. The period of tion is about fifty-one days. Therefore the young are born in and May. The number of young in a litter varies from two to the average number born to adult parents being five. In the state foxes are monogamous. The male has only one con least only one in a season, and while the young are being r he dutifully forages for them. In confinement, however, one sometimes has been mated successfully with two or even t females. In certain cases this may be desirable, and at an adva stage of the business may offer no difficulties, but at first it visable to handle the animals in pairs. It is possible, also, as pr in a number of instances, to allow male and female to rema gether throughout the year without bad results, but it is much be to keep them separate, except during the mating season. T may be paired in December or January and separated in Mar April. The females should be kept in the small inclosures ousty and the young removed when weaned. The males, if regu fed, are not quarrelsome, except in the rutting season, and th fore during the greater part of the year may be allowed to run together in the larger inclosures. The separation of the sexes is not, as many suppose, to prevent the male from viciously killing the young; for, unless suffering from hunger, he usually is a model parent, and has even been known to climb a high fence in the effort to carry food to his offspring. But the presence of the male often results in injury to the female during pregnancy, resulting in abortion; or it excites her unduly after the young are born, leading to rougher treatment than they are able to stand.

When born the young are small and weak, but if all is well they grow rapidly, and when about six weeks old begin to come out to play and to lap a little milk or to take an occasional bit of solid food. If allowed to do so, they will continue to nurse for nearly six months. They breed the first season, when a little less than a year old, but usually produce only two or three young.

Foxes in confinement, as in their natural state, show considerable individuality. Some are much better breeders than others; some can never be induced even to mate, and others mate but do not produce young. Their wild nature dominates most of their actions, and it is rare that one becomes really tame. They are constantly in a state of fear, and it is only by the greatest care that confidential relations can be established between them and their keepers. This fear is probably the chief cause of the failure to breed regularly. It may cause the female to refuse the attentions of the male, or having received them, she may prove infertile, or she may become excited so as to injure herself and give birth prematurely. But worst of all, even after producing a litter of healthy young, she may be so solicitous for their safety that in her effort to get them out of imaginary harm's way she maltreats or kills them. Often when her young are just born or only a few days old she will carry them about the inclosure all day, apparently seeking a place to hide them. Perhaps she digs a den in the ground and removes the young one by one from the warm box to the cold ground. Thus they may be moved successively to a number of freshly dug dens and to and from these and the box until the little things are so mauled and exposed that they die.

Keeping the foxes in a secluded place free from visitors is not sufficient alone to overcome these difficulties. Although strangers should be kept away, a regular attendant should visit the animals daily and use every effort to gain their confidence. This is not easy, and a great deal depends upon the personality of the man in charge. One not thoroughly interested or not naturally fond of animals, and therefore slow to understand their ways, is not likely to succeed. Careful observation and a faculty of intuition enables a good keeper to anticipate the moods of the animals and to interpret their actions at critical times so as to act quickly and without violence. He knows just when the foxes are getting too much food, just when the sexes should be brought together or separated, when the female becomes pregnant, when the young should be born, when they need special attention, and when they may safely be left to the exclusive care of the mother. He is not overinquisitive as to the number of young that are born, and seldom needs to disturb the anxious parent, relying on her actions to show whether or not the little ones are thriving.

GENERAL HABITS OF FOXES IN CONFINEMENT.

Aside from the matter of propagation, the mere keeping of foxes in confinement has proved simple. It is true that they do not become very tame, or only in exceptional cases. Even the offspring of several generations of foxes reared in captivity remain wild and, except when young, evince more or less distrust of human beings. Still, life in the wire inclosures does not seem unpleasant to them. When thinking themselves unobserved they play together or lie contentedly stretched at length in the sun. Cold weather has no terrors for them and snow is a delight. At times of alternate freezing and thawing it is dangerous to allow them to lie down on snow, as they may thus seriously injure their coats. They rarely make determined efforts to escape from the inclosures, except during the first few days of captivity. Then they dig for perhaps a foot at the extreme edge of the inclosure where the wire enters the ground. If the wire does not enter the ground, but is merely turned in at the bottom for some 2 feet, they dig only in the angle, and obviously can not accomplish much, as they must work by thrusting their paws through the mesh

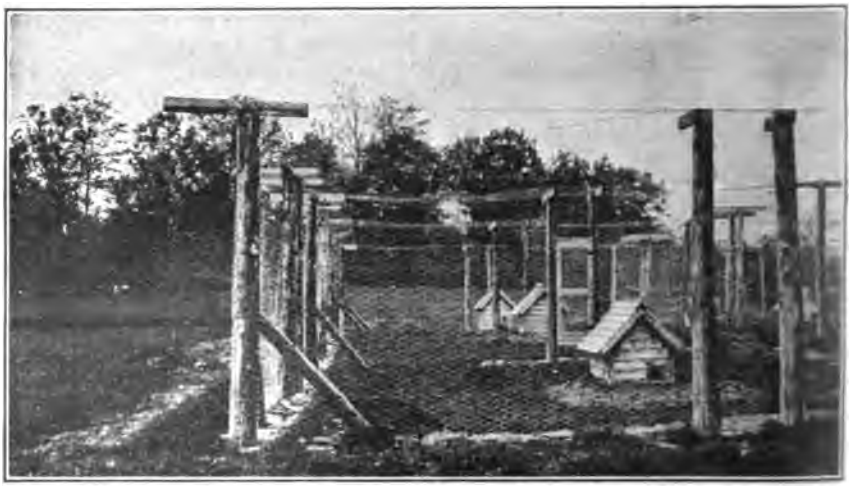

FIG. 8.—Yards of a successful Maine fox farm.

of the wire. If stones are placed along the edge of the wire, they make no effort to dig at all, as tunneling under seems never to occur to them. So far as known none have escaped by digging, but a few have managed to climb out. The overhanging wire at the top effectually prevents this at most times, but an unusually heavy drift of snow in winter sometimes enables them to reach an elevation from which they can leap to the top and scramble out. In several cases, however, they have returned to the inclosures and climbed back or have been caught in traps set for them nearby. When at large, foxes do not often climb trees, but in confinement they do so readily and voluntarily, often lying curled up in the thick branches of a spruce or fir for hours.

Although in general of suspicious nature and inclined to be unfriendly to man, foxes in confinement usually maintain good relations among themselves. If well fed, they seldom fight, or if they do it is without fatalities. In a few cases two or more have turned upon a fellow captive and killed or badly crippled it, but usually this has been due to underfeeding or to improper handling during the rutting season. Except when young, they snap and bite at their keeper if he attempts to handle them; so they are separated or transferred by driving them from one inclosure to another through gates arranged for this purpose. When this is not feasible, they may be driven into boxes and so moved. They stand shipment well and may be boxed and sent on a journey of several days by rail with perfect safety. Foxes have been shipped even so far as from Alaska to Maine, but unless specially cared for in transit they do not often survive such a long journey.

DISEASE.

So far as known, fatal disease has been so rare as to be negligible in any general consideration of fox raising. Here and there an animal has died of some unknown internal complaint, but no particular disease has manifested itself. Nothing in the nature of an epidemic has thus far appeared, and even minor diseases have been exceedingly few. Improper feeding causes temporary bowel troubles and a few foxes are reported to have died from a " dizziness in the head," supposed to have been caused by eating too much meat. Fleas occasionally have proved troublesome and may even cause the death of young animals. No doubt foxes may contract mange and other diseases to which dogs are subject, but if kept in cleanly quarters and fed properly they are reasonably safe.

CAUSES OF FAILURE.

The principal cause of failure in attempts to breed foxes appears to have been lack of close personal attention. This is required even with animals which have long been thoroughly domesticat horses, dogs, cattle, and poultry. How much more then is n sary in the case of an animal suddenly transferred from th state to restricted quarters and unnatural conditions. The b of fox raising is new, and he who would succeed must give it c thought, studying the moods of the animals and preparing hi to intelligentl emergencies a arise. A res ful, perseveri with a natura ness for anima assuredly suc where one le qualified woul suredly fail.

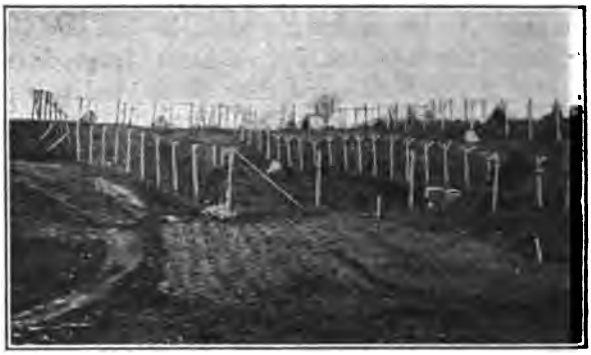

FIG. 9.—Fox yards on open ground.

Many men o wise well qua do not succe account of the half-hearted way in which they undertake the bus They do not consider it of prime importance, but make it only a junct to other work. Hoping that it may bring them a littl plementary income, they trust it to proceed automatically, r while devoting their best thought and energy to something Practically the only conspicuous successes in fox raising have attained by men who have given it their best efforts.

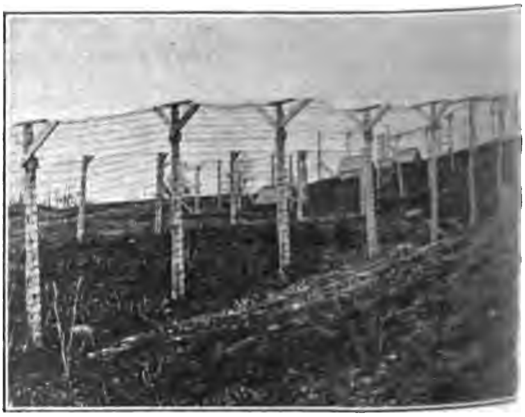

FIG. 10.—Fox yards showing detail of outer fra

Companies formed for the sole purpose of raising foxes, however, have uniformly failed. This has been due largely to the great difficulty of securing a hired keeper having the necessary personal interest. Scarcely less disastrous has been the advocacy of different methods of manage by different stockholders, each insisting that his theoretical is the only proper one. Many attempts to raise foxes have of such short duration that their failure can scarcely be taken account in considering the practicability of the business. Such ures might have been turned into success by persistence; in fact, no fox breeder has succeeded from the start. It is interesting to note also that some men, while able to handle foxes well, do not develop the business properly because they are not sufficiently venturesome. Having raised a litter of excellent foxes, the enterprising beginner looks to the future and selects the best of them to add to his breeding stock. Some, however, can not withstand an offer of a few hundred dollars for a good pelt when they think of the casualties that may befall the animal bearing it, and so when the next season comes around their breeding stock is neither larger nor better than before. Among other causes which deter timid owners from retaining many valuable foxes are the possibilities of theft and the serious harm which may be inflicted by malicious trespassers. At present it is not easy to establish ownership of an escaped fox in a country inhabited by wild foxes. It is therefore possible for persons so inclined to contrive the escape of valuable animals, and when they are free to kill them and market their skins.

In the actual handling of foxes all minor difficulties may be easily surmounted by practical men. Failure usually consists only in details relating directly to the breeding; that is, the foxes will not mate, they are infertile, or they fail to rear their young. Experienced breeders attribute these difficulties to two principal causes: (1) Overfeeding, causing the animals to become so fat that they do not breed, and (2) lack of seclusion and quiet, causing excitability and apprehensive nervousness. These matters have already been discussed.

BREEDING FOR IMPROVED STOCK.

Hope for increased profits in fox raising lies almost entirely in improving the stock by selective breeding. The darker the animal the more valuable its pelt. Hence the object of every breeder should be to produce pure black foxes, or as nearly pure black as possible. To do this he must retain his darkest and most valuable animals for breeding, selling only the poorer ones. The temptation to sell animals of high value is often very great, but in the long run such animals are likely to be more profitable if kept for breeding. The possibilities of modification and improvement by selection are fully as great with wild animals as with domestic, and already have been demonstrated in the case of foxes. Some of the highest priced fox skins ever put on the market have been from animals reared in confinement and improved by selective breeding.

Since the silver fox is only a color phase of the red fox, its progeny might be expected often to revert to the red color. As a matter of fact, however, silver foxes bred in confinement have almost invariably produced only silver offspring. Moreover, it is believed that in silver foxes of known red ancestry any tendency to red offspring may be "bred out" in a few generations.[a] Evidence o important point is scanty, but the experience of one breeder s cited. Beginning with a red female and a silver male, fiv were raised, two red, two cross, and one silver. The silver pro from this mating was then bred to an unrelated silver, the r being two cross and one silver. The silver thus produced wa bred for two seasons and gave birth to seven young, all of were silvers.

Breeding for disposition is perhaps fully as important as br ing for color. So far this has not been attempted to any extent evidently it may be of great importance in overcoming some of principal difficulties now encountered. By selecting those an which show the least aversion to man, due regard being pa other qualities, as prolificness, a strain may be obtained which breed with the certainty of our domestic animals. This in should produce a thoroughly domesticated race of foxes, a re of inestimable value, amply justifying the utmost efforts. Alth it may not be fully accomplished by those who begin it, every bre should keep its importance in mind, for every slight improve will be to his advantage, and in the end the unqualified succ the business will be assured.

Some have thought to obtain a more prolific and more trac animal by crossing foxes with suitable breeds of domestic d but their experiments have failed. Although foxes are classe in the dog family they are placed in a separate genus (*Vulpes*) fering from that (*Canis*) which includes the wolves, jackals other canines, from some of which domestic dogs undoubtedly w derived. The period of gestation in the dog, as well known, is a sixty-three days, whereas in the fox it is about fifty-one. There though perhaps not impossible, the successful crossing of dogs foxes is scarcely to be expected.

Slight improvement of individual male animals not inten for breeding may be obtained by castration. This has been tr with red foxes and found to produce an animal of somewhat creased size, yielding a correspondingly more valuable pelt.

PREPARATION OF SKINS.

The preparation of skins requires some care, but no special in ments or preservatives. The opening and only cut is made w sharp-pointed knife, beginning on the bottom of one hind fo extending up the hind side of the leg to the vent and thence dow other leg to the foot. The entire body is removed throug opening, using the knife to separate the skin when necessary, and proceeding down over the head to the lips, where the final cuts are made. Thus the skin is turned completely inside out. The tail bone must be carefully withdrawn, preferably by the use as a vise of two firmly held sticks (or a split stick), through which the bone is passed. To facilitate this it may sometimes be necessary to slit the tail on the underside. The skin is then carefully fleshed—that is, all the fat and bits of flesh adhering to it are removed. To dry the skin it is slightly stretched on a long, narrow, somewhat tapering board with a blunt, rounded end. After slipping over the board (hair side in) it should be hung in a cool, dry place and allowed to dry gradually. Ordinarily no preservative is necessary, and the drying should not be hastened by exposure to the sun or artificial heat.

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[a] Doubtless in conformity with Mendelian principles, but no careful ex ments as yet have been conducted.

PROFITS.

The expense of raising foxes is comparatively small. After building yards and securing stock, running expenses are slight. Without making extensive estimates of the profits of a well established fox farm, it may be said simply that every silver fox raised is likely to yield a pelt having a market value of over $100. Even pale skins bring this figure, and darker ones much more. Pure black skins command almost fabulous prices, ranging from $500 to $2,000. It is therefore evident that a moderate income may be derived by raising comparatively few foxes. In the present stage of the business the sale of foxes for breeding stock is very profitable, as the live animals in good condition often bring fully twice as much as their cured skins. In fact, good, live silver foxes seldom can be obtained for less than $500 per pair, and much higher prices have been paid.

The high prices paid for silver fox skins undoubtedly are due, at least in part, to the rarity of the animals, and the extensive production of such skins would necessarily tend to a reduction in price. Increasing population and wealth, however, insure a large future demand for fine furs, and no great decrease in prices is likely to occur until production reaches large proportions. Prominent wholesale dealers are of the opinion that if the production of silver foxes were doubled and redoubled within a few years prices would not thereby be affected materially.

The greater part of the world's fur is sold annually in London at two auction sales. In 1905, as reported in the Fur Trade Review, the total number of silver fox skins offered at the two sales was 1,097. This includes all grades from very pale skins to pure black. No classification is made other than by values, but it is probable that not over 100 of these skins were pure black. In 1906 the total number was 1,934 skins, or nearly double that of 1905, yet the average price is reported 10 per cent higher. The total for the spring sale of is 1,909 skins, and according to reports prices were again 10 per higher than the previous year. One report contains the foll statement: "The fashion for this article continues, and the fine skins are specially in demand. Prices, however, on the whole, about the same as last year. * * * the highest priced skin ized £440" ($2,140). Furriers also state that changing fashi not likely to alter prices, for the market is world-wide, and a di ished demand in one or more countries is invariably offset by an crease elsewhere. At present the higher-priced silver fox skins sold mostly to France and Russia, but the demand in the Un States is increasing.

SUMMARY.

From the foregoing it is evident that silver foxes can be a fact are being propagated in confinement. Like most new en prises, fox raising is a business regarding which opinions vary. T favorable facts are that silver foxes are easily and securely kept simple wire inclosures; that suitable food for them is cheap easily obtainable; that they are not subject to serious diseases, that their disposition and the quality of their fur can be impro by selective breeding. Opposed to these are the unfavorable f that they are by nature suspicious, nervous, and not inclined to pose confidence in man; and that, largely for these reasons, they not breed regularly and successfully, except when cared for by perienced persons more or less gifted in handling them.

The number of persons now engaged in the business is relati small, and the work is still experimental, yet many of the initial culties already have been overcome. Numerous minor failures explainable in large measure, and are offset by several conspicu successes. It is therefore probable that under proper manage fox raising will be developed into a profitable industry, and it perhaps not too much to expect that a domestic breed of f will be produced. Only time can show how far such expectat will be realized, but present indications must be regarded as encouraging.

FARMERS' BULLETINS.

The following is a list, by number, of the Farmers' Bulletins available for distri-
tion. The bulletins entitled "Experiment Station Work" give in brief the results
experiments performed by the State experiment stations. Titles of other bulletins
e self-explanatory. Bulletins in this list will be sent free to any address in the
nited States on application to a Senator, Representative, or Delegate in Con-
ess, or to the Secretary of Agriculture, Washington, D. C. Numbers omitted have
en discontinued, being superseded by later bulletins.

2. The Feeding of Farm Animals. Pp. 40.
4. Hog Cholera and Swine Plague. Pp. 16.
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9. Experiment Station Work—III. Pp. 32.
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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 329.

Experiment Station Work,

XLVII.

Compiled from the Publications of the Agricultural Experiment Stations.

OW-GRADE v. HIGH-GRADE FERTILIZERS.
MPROVEMENT OF SANDY SOILS.
RY FARMING.
EED SELECTION.
VERGREENS: USES AND CULTURE.
NUT GROWING IN MARYLAND.
"HOGGING OFF" CORN.
MINERAL MATTER IN FEEDING STUFFS.
PREPARATION OF MISCIBLE OILS.
AN AUTOMATIC CHEESE PRESS.
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MAY, 1908.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
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1908.

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  Tuskegee Station: *Tuskegee Institute;* G. W. Carver.[a]

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New Hampshire—*Durham:* E. D. Sanderson.[a]

New Jersey—*New Brunswick:* E. B. Voorhees.[a]

New Mexico—*Agricultural College:* L. Foster.[a]

New York—
  State Station: *Geneva;* W. H. Jordan.[a]
  Cornell Station: *Ithaca;* L. H. Bailey.[a]

North Carolina—
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  State Station: *Raleigh,* B. W. Kilgore.[a]

North Dakota—*Agricultural College:* J. H. Worst.[a]

Ohio—*Wooster:* C. E. Thorne.[a]

Oklahoma—*Stillwater:* W. L. English.[a]

Oregon—*Corvallis:* J. Withycombe.[a]

Pennsylvania—
  State College: T. F. Hunt.[a]
  State College: Institute of Animal Nutrition, H. P. Armsby.[a]

Porto Rico—*Mayaguez:* D. W. May.[b]

Rhode Island—*Kingston:* H. J. Wheeler.[a]

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South Dakota—*Brookings:* J. W. Wilson.[a]

Tennessee—*Knoxville:* H. A. Morgan.[a]

Texas—*College Station:* H. H. Harrington.[a]

Utah—*Logan:* E. D. Ball.[a]

Vermont—*Burlington:* J. L. Hills.[a]

Virginia—*Blacksburg:* S. W. Fletcher.[a]

Washington—*Pullman:* R. W. Thatcher.[a]

West Virginia—*Morgantown:* J. H. Stewart.[a]

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EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

LOW-GRADE V. HIGH-GRADE FERTILIZERS.[b]

n a recent report of fertilizer inspection in West Virginia, J. H. wart and B. H. Hite call attention to the large amount of low- de fertilizers used in the State and make an earnest plea for the of high-grade materials, asserting that "it is very poor business anyone's part to invest in low-grade fertilizers."

or every reason that may be assigned for using fertilizers at all there are ays two reasons for using high-grade fertilizers, and the first is the saving ost.

rom the moment the raw materials leave the mine, slaughterhouse, or gar- e dump until they are in the soil the cost of handling is one of the heaviest ns the farmer eventually has to meet. Such expenses are the same for a of fertilizer containing 1 per cent of plant food as for a ton of fertilizer aining 2 or more per cent. The average freight bill alone on fertilizers ped into this State is over $2. This and a number of like bills could, of se, be cut in two by purchasing fertilizers containing double the amount ctual plant food. The cost of hauling fertilizers from warehouses, cars, oats to the farm is an item worth considering if only for wear and tear on es and wagons. Why make two trips if one will do?

ncentrated high-grade materials necessarily command a higher price, but difference is not always proportional to the difference in actual plant food, high-grade materials as a rule being cheaper, pound for pound of actual t food.

he statement is illustrated by comparisons of high-grade and low- de fertilizers, the analyses of which are reported in the bulletin. authors say:

purchasers of commercial fertilizers would only get into the habit of calcu- ig the number of pounds of plant food in a ton of every fertilizer in which are interested they might often be surprised to note how much they might saved on the quantities of plant food they have been purchasing, or how h more plant food they might have purchased for the same money.

ut there is yet another and a better reason for using the concentrated fer- ers. It has to do with the fitness of the various sorts of fertilizer materials

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A progress record of experimental inquiries, published without assumption of onsibility by the Department for the correctness of the facts and conclusions rted by the stations.

Compiled from West Virginia Sta. Bul. 114.

for supplying the needs of plants. As a rule that has but few exceptions more concentrated the materials from which the fertilizer is made the suitable (or less objectionable) they are as food for plants.

It is pointed out that—

> Farmers will get concentrated fertilizers whenever they decline to accep other kind. By purchasing concentrated fertilizers they will save on the of actual plant food, and they will not get low-grade nitrogen and p materials, for the simple reason that a concentrated fertilizer can har compounded from low-grade materials.

IMPROVEMENT OF SANDY SOILS BY GROWING FORAGE CROPS

In farm management the maintenance of soil fertility is alwa most vital problem, and on lands sufficiently fertile all that is ne sary to prevent deterioration is to hold the crop-producing pow the soil at the same level. Adequate fertility in soils, however, not very common, and generally the first question is how the fer may be increased. The methods of soil improvement vary with d ferent kinds of soil, and the difficulties encountered are largely termined by the soil character. Light soils, for instance, are usu much more difficult to improve than similarly located heavy A consideration of this subject, together with the results secur the improvement of the sandy soils in south Jersey by mea growing forage crops, has recently been presented by E. B. Voor and J. G. Lipman, of the New Jersey Experiment Station.

In discussing the general character of light soils, the authors p out that unimproved sandy or sandy loam soils can not furnis much plant food or supply as much moisture to growing crops a the clay and clay loam soils are capable of doing. Attentio further called to the fact that the coarseness of sandy soils prev them from readily retaining the plant food applied to them and moisture they receive. The fertilizers given are easily washed dow ward into the subsoil by the rains, and dry weather soon robs the soils of their moisture. Extremely open or coarse, sandy soils a considered amenable to profitable cultivation only when the rainf is abundant and well distributed, the subsoil sufficiently compact, a the water table near enough to the surface.

In treating of the physical properties of sandy soils, their re tion to moisture, heat, and air is discussed. It is shown that ow to their great permeability sandy soils may be tilled early in th spring, when heavier soils are still too wet to be worked. They a earlier and warmer than heavy soils because they are drier. On other hand, these loose and open soils quickly lose their water by le percolation and evaporation, and at the same time, on account o

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[a] Compiled from New Jersey Stas. Bul. 211.

their limited capillary power, are unable to replenish this loss rapidly by drawing upon the water supply of the subsoil. In the heavier and more compact types of soil capillarity is much more active.

The openness of light soils admits air freely and thus intensifies the chemical and bacteriological changes going on in the soil. Under these conditions plant food is made available more quickly and the rock particles weather more effectively than under the conditions obtaining in a heavy soil, but these processes are carried on so rapidly that the humus burns out too fast and the losses of plant food are too great.

Chemical studies of the sandy soils of south Jersey reveal for the most part their poverty in plant food. Some soil samples examined contained as much as 98 per cent of pure quartz. Lime was found in small quantities, magnesia and potash in traces only, and the proportion of organic matter was also very low.

It is stated that the bacterial activity of soils is directly influenced by the supply of air, moisture, and warmth, and by the chemical composition. Well-aerated or open soils favor the development of bacteria requiring large quantities of air for their growth, and these species cause an intense decomposition of the humus. This is offset to a great extent by the rapid loss of water from these soils, as the bacteria can not multiply when the soil moisture falls below a certain point. In the heavier soils not so well aerated and not so readily affected by dry weather, the changes in the development of bacteria are not so sudden, and therefore the supply of plant food, and especially of nitrogen, is much more uniform than in the open sandy soils.

For the improvement of sandy soils it is recommended that thorough aeration be discouraged by methods of tillage, by applications of fine-grained materials or of substances readily pulverized, and by additions of large quantities of humus-forming matter such as green crops or barnyard manure. Sufficient humus in the soil prevents the too ready access of air and increases the moisture-holding capacity of the soil. Although sandy soils are quite poor in plant food this condition does not preclude the possibility of their improvement. Phosphoric acid and potash may be supplied at a comparatively small cost and the humus may be furnished in either animal manures or green manures. In considering this phase of the work the authors show that the use of animal manures is not indispensable. They regard horse manure as too expensive for general farm crops, because it is not always handy and also as injurious in some cases through the introduction with it of weeds and fungus diseases. The experiments they conducted were made with a view of showing that the humus content of sandy soils could be increased by means of green manuring and the use of fertilizers alone. Systems of green manuring were found particularly effective in this connection on account of the relatively greater need of nitrogen and humus in light soils and their greater power to convert green crops turned under into available plant food. Leguminous crops, such as crimson clover, cowpeas, soy beans, vetches, etc., are recommended for this purpose because they add both humus and nitrogen to the soil. The limitations of green manuring enumerated are the use of large quantities of water by the crops, the need of an abundant supply of phosphoric acid, potash, and lime in the soil, and the drying effect of the green crops when plowed under. Where the rainfall is sufficient the disadvantages of green manuring are largely reduced.

With reference to the activities of germs in the soil it is stated that by increasing the amount of humus in sandy soil its water-holding capacity is increased and thereby a more uniform bacterial development and a more uniform supply of available plant food assured. The increase of humus in sandy soils encourages the growth of bacteria as a result of the greater content of organic matter and of moisture, and their development is discouraged on account of a less thorough aeration of the soil.

The nitrogen-fixing or nitrogen-gathering bacteria associated with the growth of leguminous plants find the conditions existing in sandy soils extremely favorable for their development and for the fixation of large amounts of atmospheric nitrogen. The facility with which the air circulates in these soils favors the formation of nodules on the roots of leguminous crops. It is pointed out that the nodule bacteria take considerable quantities of nitrogen or oxygen from the air surrounding the nodules, and as in sandy soils this air is frequently renewed the best conditions for the growth of the organisms are created. It has been observed that in compact, fine-grained soils, where the air does not penetrate so readily to greater depths, the nodules on the roots are all near the surface, whereas in sandy soils they are distributed lower down on the roots of the plants. Another factor strongly favoring the fixation of nitrogen in sandy soils is the comparatively small proportion of available nitrogen present in them.

It is pointed out that leguminous crops new to a particular region may fail to develop nodules because the proper organisms are not present in the soil. In south Jersey soy beans, alfalfa, and vetch are more or less new and may fail to develop nodules. In the experiments conducted soy beans grown on one plat during the first season failed to develop nodules, remained yellow and small, and evidently suffered for lack of nitrogen, while a crop of cowpeas on an adjoining plat grew vigorously and was of a dark color. The soy beans had no nodules on their roots, while the cowpeas were abundantly provided with them, showing that the bacteria producing nodules in the two crops are not the same and that the soy bean germs are not naturally present in the sandy soils of south Jersey. When some earth was obtained from a field where a vigorous crop of soy beans had been raised and applied to the soils in question very satisfactory yields of soy beans were as a rule secured.

While large amounts of lime are not required for sandy soils, applications of lime are of value in that they encourage the formation of humus substances which help to fix potash and phosphoric acid. As lime encourages the activities of various kinds of soil bacteria and thus tends to hasten the process of decay and nitrification, sandy soils should be limed less frequently and smaller dressings should be given than in treating heavy soils. Ground unburned lime is likely to give better results than burned and slaked lime. One-half ton per acre of ground oyster-shell lime may show results on sandy soils while remaining entirely without effect on a heavy soil. It was observed that an adequate supply of lime is important in both heavy and light soils in promoting the growth of most leguminous crops, and especially of alfalfa and of various clovers.

With these different points in mind, the authors conducted an experiment from 1904 to 1907, inclusive, to demonstrate to what extent the crop-producing power of south Jersey sandy soils might be increased and the financial returns raised by the use of fertilizers, green manures, and the growing of forage crops in proper rotation. One acre of land divided into five plats was devoted to the work. The soil, fairly uniform in character, was distinctly sandy, with a large proportion of fine sand. In preparing the land 1,000 pounds of lime, 320 pounds of acid phosphate, 100 pounds of ground bone, 160 pounds of muriate of potash, and 150 pounds of dried blood were applied per acre. Three of the plats received each in addition a top dressing of nitrate of soda at the rate of 80 pounds per acre after the crops were well started. With the exception of the first season, two crops were harvested each year. The rotations included corn, wheat, rye, millet, beets, mangels, cowpeas, soy beans, vetch grown alone or with oats or rye, crimson clover, red clover, and alfalfa. The leguminous crops for the four years included five of crimson clover, four of cowpeas, three of soy beans, six of vetch grown alone or with rye, wheat, or oats, and one crop each of red clover and alfalfa. Although no effort was made to establish a complete soiling system, succulent forage was available for a considerable portion of the growing season. The returns from the land showed a gradual and marked increase. Excluding the returns of 1904, when only one crop was harvested, it is shown that the value of the crop per acre in 1905 exceeded the cost of fertilizer by $46.92, in 1906 by $64.07, and in 1907 by $76.90. T figures do not include an allowance for the cost of seed and lab it was the purpose of the experiment to demonstrate merely th growing of forage crops on light soils may be made both pra and profitable, while increasing at the same time the produ capacity of the land.

From the results obtained it is considered not unreasonabl assume that by systematic cropping and fertilizing millions of of sandy soils in New Jersey and other States of the South Atl seaboard now uncultivated and unproductive may be profitably u ized " for dairy purposes to supply local needs, and to furnish be a supply of dairy products for the large centers of population m or less distant. * * * They emphasize once again that the have before them a prosperous future, and that some day the destined to be the scene of intelligent farming and of highly profit returns, where at present they are scarcely tilled at all."

DRY FARMING.[a]

The extraordinary interest in so-called dry farming which has awakened in recent years, and the rapid taking up of land for t purpose has emphasized the importance of a careful study of conditions, possibilities, and limitations of the practice.

J. J. Vernon, of the New Mexico Station, has made a thor study of the conditions and possibilities of successful agricultur dry-farming methods in certain parts of that Territory. In defi the term dry farming it is explained that the practice include deep plowing before the rainy season sets in, in order to provid the soil a capacious water storage reservoir and an ample spac root development; (2) light, deep, even seeding or planting in a w prepared, moist soil; (3) frequent, thorough, level cultivation bef as well as after sowing or planting; (4) the use of seed bred selected for the conditions prevailing; (5) the use of machinery large capacity; (6) the adoption of methods for the concentratio crops."

In the earlier operations of agriculture in this as well as other countri most fertile areas were the first to be brought under cultivation. This often determined by the vegetation already growing upon the land in a state. Since it is well known that the right amount of water properly tributed throughout the growing season in a very large measure determine productiveness of a soil, hence those areas over which the rainfall was abu and well distributed were occupied and cultivated first. As the popu increased those areas less favorably situated and not so well watered

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[a] Compiled from Colorado Sta. Bul. 123; New Mexico Sta. Bul. 61, U Dept. Agr., Bur. Plant Indus. Bul. 103. See also U. S. Dept. Agr., Farm Bul. 262, p. 15.

> occupied. The seeking for new areas has gone on until the lands [heretofore considered only fit for range purposes on account of scanty rainfall] are now being brought under cultivation.

It is pointed out that coincident with the bringing in of less valuable areas, the work of the organized agencies of agricultural investigation and of the educated and thoughtful farmers have wrought wonders in the improvement of farm practices.

> Inventive ingenuity has supplied improved machinery with which many operations are rendered practical that were heretofore either impossible or impracticable. With the new methods of handling soils and with the advance in the knowledge of methods, crops are now successfully grown on what are termed dry farming areas.
>
> With the same methods and machinery these lands could have been cultivated with the same degree of success many, many years ago had there been the necessity. However, it must be remembered that there is a limit even at the present time to which we can go, although the investigations of future years may disclose methods whereby the present limits may be far surpassed.
>
> There are three general groups into which the agricultural lands of the Territory, so far as dry farming is concerned, may be placed: (1) Sections where crops can be grown annually; (2) areas where crops can be grown only biennially; and (3) lands where the rain and snow fall is insufficient for regular crop production. Such grouping will not hold good throughout a long series of years, for it may and no doubt will happen that during a series of dry years, in sections where crops have been grown annually, crops can be produced only biennially.

As regards crops suited to dry farming Professor Vernon says:

> There is quite as large a range for adaptation, amelioration, and breeding with dry farming crops as with those grown under humid conditions. The necessity for such effort is far more urgent, and the reward quite as promising.
>
> Crops must be selected or developed that will fit the environments, and there seems to be quite as large a field for investigation in the improvement and development of crops suited to the various conditions in the dry farming sections as in the improvement of methods of handling the soil. * * *
>
> There is little doubt but that strains of seed of certain crops which have been successfully grown for years under trying semiarid conditions will be in great demand. As a result of this demand we may reasonably expect pedigreed dry farm crops to appear and they will fill an important want.

Some of the crops which have been especially suited to dry farming are—

> (1) **Cereals.**—Wheat stands at the head among the cereal crops for dry farming areas and it probably stands at the head of all crops for this purpose when everything is considered—adaptability to dry farming conditions, cost of production, profits, etc. There are certain classes of wheats that do best under droughty conditions. The durum or macaroni wheats seem to do exceedingly well when compared with other classes, yet there are varieties among other classes which also do well on dry farms. Spelt, oats, rye, and barley are all used on occasion. Barley is probably the poorest crop mentioned, because it is

comparatively a shallow rooted crop and for this reason likely to prove less valuable than a crop which forages more deeply for its food.

(2) **Sorghums.**—Both saccharine and nonsaccharine sorghums are grown. Fodder cane, Kafir corn, Jerusalem corn, and durra belong in this class. They should be sown for hay with a hoe drill or planted with a corn planter and cultivated. The sorghums may also be double rowed, i. e., planted in groups of two rows about 8 inches apart and cultivated.

(3) **Millets.**—Among the millets are found some of the most paying dry farm crops. Some of them grow and mature with a remarkably small amount of moisture present in the soil and at the same time the period of growth is very short.

(4) **Legumes.**—There are a few legumes that have shown value as dry farm crops. Peas, beans, and alfalfa are the most promising, although in order to secure a stand of alfalfa it will very probably require summer fallowing one year in order to accumulate sufficient moisture to insure perfect germination. After a stand is secured alfalfa has given good results in some sections. The alfalfa should be sown with the hoe drill and rather deeply for such small seed.

(5) **Vegetables.**—Garden vegetables form an important group. They add so greatly to a bounteous table supply. Many vegetables grow to the proper stage for consumption in a few weeks, and therefore are surer than almost any other class of crops. If markets are available they may be made a source of considerable revenue.

(6) **Trees.**—Both fruit and shade trees are grown in districts where dry farming is practiced. The home surroundings may be made more comfortable and greatly improved in appearance by the free use of shrubs and trees. The same care, however, must be exercised in the selection of the kinds to plant and in their care as is used with field crops. The first two or three years, until they become deeply rooted, is the most critical period in the life of a tree or ornamental shrub. Cultivation during that period should be constant and thorough.

Among the practical suggestions regarding methods of culture and the reasons for their adoption made by Professor Vernon as a result of his observations are the following:

Fall seeding of cereals is preferable to spring seeding wherever the conditions will permit for the following reasons: (1) The work is distributed over a longer period; (2) the root system of the crop becomes well developed, so that spring growth is more rapid; (3) the growth above the surface of the ground, though sometimes small, serves a valuable purpose by modifying the windsweep at a time when its effects are most marked, thus preventing, in a measure at least, the blowing of the soil from around the roots of the plants, and, at the same time, holding the snowfall upon the ground until it melts; (4) the crop covers the ground earlier in the spring, thus reducing the loss of moisture through surface evaporation; (5) the crop usually ripens earlier, a feature that is important for two reasons: (1) The work of preparing the ground for the next crop can be begun earlier, and (2) the crop may escape frost more frequently in sections having short seasons.

It is important to retain the snow upon the land, especially in sections where it forms a large part of the total precipitation. The snowfall may be retained in several ways: (1) By leaving the ground rough when the plowing is done late in the fall; (2) by throwing up borders across the field at right angles with the prevailing winds as winter approaches, and (3) by planting hedge s or shrubbery across the field at short intervals. The last-named method referable wherever possible.

sually less seed should be planted per acre under dry farming conditions n is used in humid sections. The less the precipitation the smaller should the amount of seed planted.

Finally, Professor Vernon warns those who undertake dry farming t "the yields in dry farming belts may be and sometimes are very ge, but it is not best to expect as large yields in dry farming belts are secured in humid sections, unless the cultural methods are very ch superior."

J. E. Payne, of the Colorado Station, who has spent many years dying the agricultural conditions and possibilities of the dry lains" of eastern Colorado, gives the following brief practical vice to that class of new settlers in this region "who have merely ough capital to put up houses, break a few acres of sod, and live ring the first six months. * * *"

(1) If you have a milch cow give her the best care possible, and get as many re as you can. Sell cream, or make good butter or cheese. Sod cowhouses e within the reach of all who can work.

(2) Keep as many hens as you can take care of. Feed well and protect from yotes and other beasts of prey. If you can raise turkeys and geese they will y. Turkeys and geese may be herded by children, and turkeys are the best asshopper exterminators known.

(3) For field crops on sod, plant early amber cane, yellow milo maize, and rn. The seed used should be grown in the vicinity if possible; if not, choose me early variety. If you are able to do so, prepare a small field for fall heat.

(4) Plant a garden. If you have no well, plant a small plat near the house nd water it with the waste water. Bury every drop of waste water beside ome vegetable by making a furrow beside the plants, and after the water has unk away fill the furrow with dry dirt. Old tin cans sunk in the ground by he side of hills of cucumbers aid in watering them economically. Punch holes n the bottoms of the cans.

If you have a well, plant a large garden, but plant all garden stuff in rows o that it may be cultivated with horse power. Use the water with the same conomy that you would if using only waste water. Never flood the ground urposely. If any should be flooded, stir it thoroughly as soon as it is dry nough.

It is a common mistake with beginners in irrigation to try to make water take the place of cultivation. The result is failure. Another common mistake is to plant a larger area than can be watered from the well. Better begin with only a few square rods and extend the area as experience dictates.

In case you can not irrigate from a well, select a small patch of ground upon which you can turn the flood water from the prairie by means of furrows. If you can make a small reservoir above the patch, do it. The reservoir may hold a few barrels of water until you have time to direct it to the plants which need it. Cultivate thoroughly and keep all weeds down.

Besides the small truck, a good patch should be planted to Mexican beans, early cowpeas, watermelons, muskmelons, stock melons, pumpkins, squashes, popcorn, sweet corn, and potatoes. These will sometimes bring good crops without irrigation. Enough should be planted so that a plentiful supply of winter food for the family will be assured. Stock melons are very productive, and if stored in sod buildings, above ground, they will furnish green food for the milch cows during winter. I have grown stock melons at the rate of 20 tons per acre. I have kept ordinary watermelons until the last of November by packing them in hay and storing them in a room where they kept cool but did not freeze. There are varieties of winter watermelons and muskmelons which are good from Christmas until March.

By planting the following seven varieties of sweet corn on the same day—and often near the last of May—I have had roasting ears from July 28 until September 26. The varieties were: Cory, Black Mexican, Perry Hybrid, Stowell Evergreen, Country Gentleman, Mammoth Evergreen, and Egyptian. The large varieties may be dried for winter use or allowed to ripen to be used parched. Parched sweet corn is a luxury, but one which is within the reach of the poorest settler. White Pearl and Queen Golden popcorn have done well for me, and my family have had many meals consisting only of whipped cream and popcorn.

Potatoes, squashes, and pumpkins may be grown successfully by keeping up a constantly successful fight against potato beetles and squash bugs. This means to battle almost daily with the pests from the time the potatoes are up until the middle of August, and from the time the squash plants are up until the squashes are ripe.

Grasshoppers are the worst enemies to field crops, but by keeping plenty of poultry the grasshoppers will be kept down.

To produce crops of any kind may require an amount of labor which seems enormously out of proportion to the market value of the produce, but we assume that people who have settled here desire to build up homes and they have come here because they failed to get homes elsewhere. It may be a comforting thing to remember that you may not be working any harder here while trying to establish independence than you would be if working by the day for some one for just enough wages to support yourselves.

A careful study of the natural conditions and the methods successfully employed in dry farming in the Great Basin has been reported by Mr. C. S. Scofield, of the Bureau of Plant Industry of this Department. The following is a summary of this report:

Dry farming in the Great Basin is limited at present almost entirely to the State of Utah, where it has been carried on to some extent since 1875 and its practice has been increasing rapidly since 1900. The work was initiated by private experiments, but the State of Utah is now supporting six experiment farms for testing varieties and working out scientifically the best rotation and tillage methods.

The precipitation comes during the autumn, winter, and spring months, differing in this respect from the precipitation on the dry lands east of the Rocky Mountains, where it comes during the summer months. Farming is successfully carried on with an annual average rainfall of 15 inches or slightly less. The annual variation in rainfall is considerable, and the year 1906 was unusually wet. Local topography has a marked effect on the amount of rainfall.

Clean summer fallowing and alternate-year cropping, together with thorough tillage, are the basis of successful dry farming in the Great Basin.

Wheat and alfalfa are the most important crops now grown on the dry lands of the Great Basin. Thin seeding is found essential to the best results with these crops.

nder the best methods of tillage the land appears to remain highly produc-, even where no other crop than wheat is grown.

ry farming is now used only as a supplement to irrigation farming. There e been few attempts to make homes on the dry lands.

he independent extension of farming on the dry lands depends upon the elopment of underground water for domestic use.

t thus appears that by means of special methods of culture and use of drought-resistant crops a considerable amount of dry farm- may be successfully practiced, particularly if supplemented by ficient irrigation to insure garden products and forage for stock ring seasons of crop failure on the unirrigated portion of the farm.

SEED SELECTION.[a]

As Dr. G. E. Stone, of the Massachusetts Station, points out, " it generally recognized that large, heavy, and well-developed seeds ll, as a rule, produce larger plants than light and poorly developed eds of the same variety. It is also recognized that seed uniform in e, weight, and development will produce crops of a more uniform pe than those grown from seed characterized by variations in velopment, etc."

He points out, however, that while " seed separation has come to vogue among growers of special crops as a means of securing ore uniform crops and plants of greater vigor, [and] seed selection f one kind or another has been in vogue from time immemorial," pecial methods of selection are not at the present time common in he case of many crops, and he believes that much more attention ight profitably be given to the matter.

Doctor Stone describes various methods which have been used for he separation and grading of seeds. " The separation of seed by ieves is one of the simplest, easiest, and most practical methods mployed and is applicable to a large number of varieties; [but] mall, light seeds are best separated by the air method, and various devices are used for this purpose." A form of the tube and bellows method referred to in former bulletins of this series[b] has been found to be well suited to such seeds and is described as follows:

> The principal features of this device consist of a foot bellows, a glass tube three-fourths or more inches in diameter and 2 or 3 feet long, and a separate air space to receive the air. (See fig. 1.) The bottom of the tube must be covered with cheese cloth with a large enough mesh to allow the air to readily pass through, but fine enough to hold the seed. The pressure of the air and the diameter and length of the neck are features which must be adjusted to one another to secure the best results. Various kinds of blowing appliances are used, all having the same object—to properly separate the seed. For our purposes we have devised an apparatus (fig. 2) consisting of a series of tubes placed in a block side to side, and while certain ones are being operated others

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[a] Compiled from Massachusetts Sta. Bul. 121.

[b] U. S. Dept. Agr., Farmers' Buls. 225, p. 10; 237, p. 12.

can be emptied and refilled. The tubes are set in holes and imbedded in paraffin, rendering them secure. The block holding the tubes is in two sections, and the two halves are held together by large screws. The tube extends to the middle of the block and rests upon a square piece of folded perforated tin "r." between which is placed bolting cloth, preventing the seed from falling through. The perforated tin and bolting cloth, which cover the lower end of the tube, are held in a horizontal position by means of a spring, and when the seeds are separated by turning the handle marked "Y" it brings the seed support in a vertical position, as shown by the dotted lines "Y," emptying the seeds into the Mason jar below "G," which is provided with a metal cover securely and permanently fastened to the under side of the block. The process of emptying the seed from the tube into the jar is easily accomplished and saves much time and labor. The top of each tube is provided with a light brass funnel having a simple shut-off at "e." Fastened to the same axis which carries the funnel there is another support which carries a bent piece of glass "t." This is for the purpose of directing the light seed into the cylinder "M." Both the funnel and the glass tubes are centered over the long tube and held in position by a simple click or spring at "O-C," and either can be readily swung in any direction. The blowing arrangement consists of a hydraulic air compressor provided with a 50-gallon tank, "A-D." This is connected with thick-walled rubber tubing, pressure gages, reducing valves, and shut-offs. The pressure is obtained by means of water, and with a large supply tank and high pressure the air supply can be kept quite constant. A special feature of this apparatus consists in the bulbs in the tubes, of which various types are used. In successful separation much depends upon the number and size and shape of these bulbs.

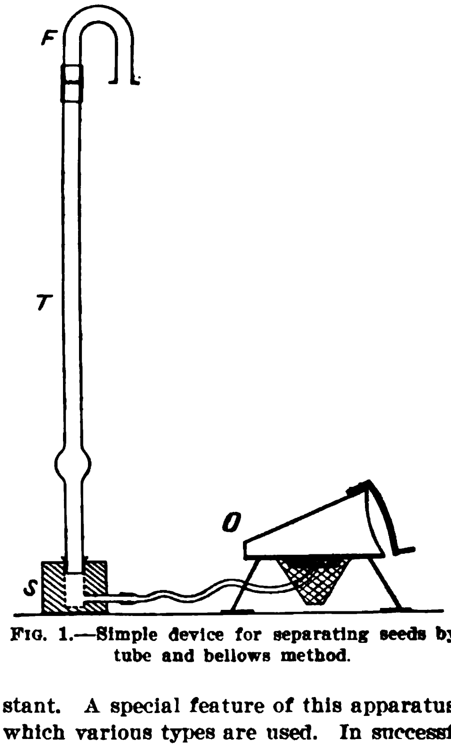

FIG. 1.—Simple device for separating seeds by tube and bellows method.

The results obtained by Doctor Stone with a number of crops confirm those of Shamel and Cobey with tobacco,[a] showing that seed separation is "an important aid in securing larger, more vigorous, and more uniformly developed crops."

EVERGREENS: USES AND CULTURE.[b]

W. J. Green and W. E. Bontrager, in a bulletin of the Ohio Station, urge that on account of their enduring foliage evergreens possess peculiar value both for shelter and ornament, and "should be re extensively planted about country homes, whether used in aight-row windbreaks or mingled informally with other trees on lawn."

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[a] U. S. Dept. Agr., Farmers' Bul. 237, p. 12.

[b] Compiled from Ohio Sta. Bul. 190.

rom the ornamental standpoint, they abound in rich dark shades of green, ially valuable as a background for deciduous trees or flowering shrubs and nts. * * *

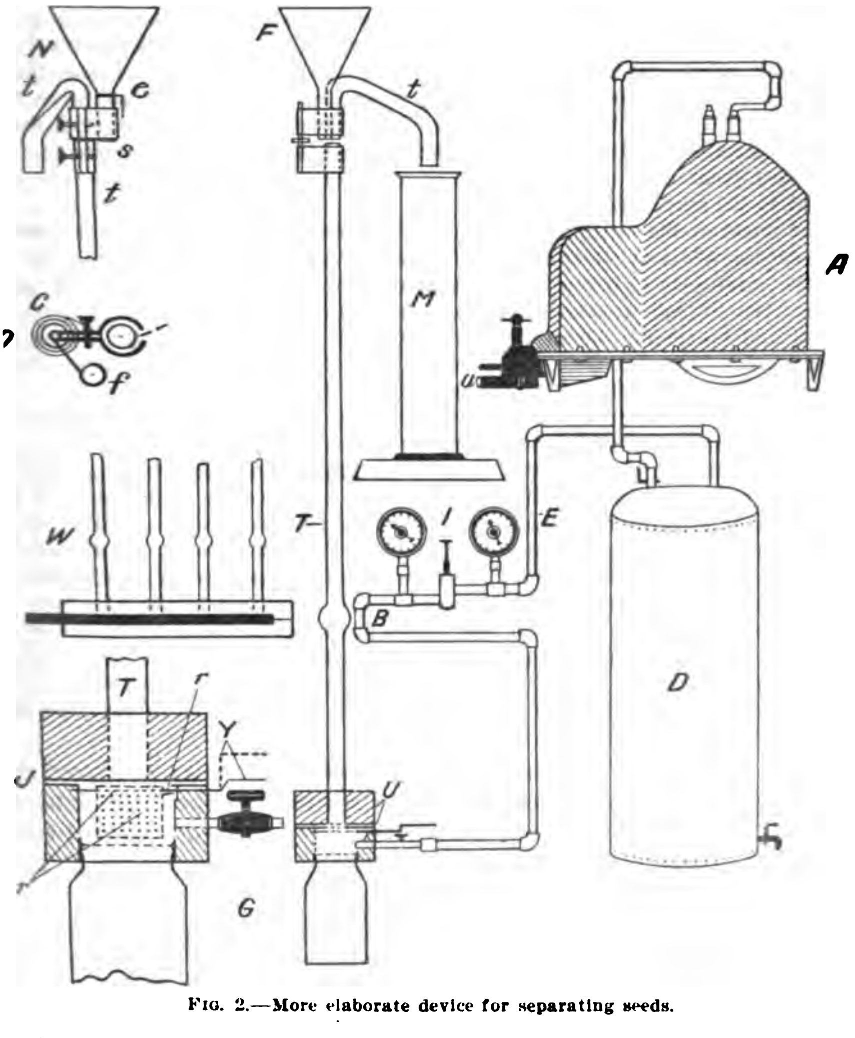

FIG. 2.—More elaborate device for separating seeds.

At all times they furnish a barrier to wind and cold, and the remarkably picturesque forms assumed by the adult specimens of many species add much to the attractiveness of a country home, especially when their boughs gracefully bend beneath a load of snow. In winter, when other trees are destitute of foliage, these majestic trees lend to the scene an air of animation which mitigates in a large measure the severity and desolation of the season. If tastefully intermingled with other trees and shrubs about the home they give a warmth of verdure and variety of outline unattainable without their use. That many of the evergreens can be successfully grown upon thin sandy soils is an additional argument in their favor.

Where grown to show the characteristic beauty of individual trees, evergreens should be grouped naturally and not so closely as to crowd upon each other, usually along the sides or at the rear of the lawn. Planting in straight lines should be avoided, and, in small groups, the disposition of trees in odd numbers is to be preferred. Immediate effects may be secured by planting thickly, but thinning should not be so long deferred as to work injury to the lower branches of those trees which it is intended to grow to maturity. The individual who expects to begin the planting of evergreens should not underestimate the importance of ascertaining what species and varieties have been found vigorous and hardy after being tested over a wide range of country under dissimilar conditions. After a beginning has been made specimens may be added from time to time as the planter determines what kinds are best suited to his needs and locality. * * *

The finest of the larger ornamental evergreens are the white pine, Colorado blue spruce, white or silver fir, oriental spruce, and American hemlock. Of the smaller ones none is better than Siberian, Hovey's golden, pyramidal or globe arbor vitæ, thread-branched Japan cypress, graceful obtuse-leaved Japan cypress, and plume-like Japan cypress. The best evergreens bearing foliage in shades of yellow are George Peabody arbor vitæ, golden pea-fruited Japan cypress, and golden plume-like Japan cypress. * * *

Probably the most valuable of all the evergreens in producing landscape pictures is the silver or white fir. Somewhat similar in color, although of a distinctly different habit of growth, is the Colorado blue spruce, which should be found in every collection. This superb tree is of iron-clad hardiness and the foliage is of a pronounced shade of blue which renders it very effective when grown in proximity to darker-colored kinds. The retinosporas, or Japan cypresses, are an extensive group of elegant small trees especially adapted to massing and also to use upon small lawns, while the dwarf Mugho pine will be found serviceable where one of low spreading habit is desired. At times in grouping trees a specimen of upright, columnar habit will be admissible, when the pyramidal arbor vitæ or Irish juniper may be appropriately introduced; but a preponderance of such trees should be avoided, as it conduces to anything but a natural, graceful landscape composition.

It is stated that dull and gloomy effects sometimes produced by excessive use of trees like the Norway spruce and the Irish juniper may be avoided by mingling with them such light and cheerful trees as the silver firs, Colorado spruce, hemlocks, and retinosporas, as well as deciduous trees.

The white birch is admirably suited to this style of planting, and, when interspersed among evergreens, its snowy bark gleaming against a background of green boughs, becomes a charming part of the winter scene. The beauty of home grounds would be greatly augmented by the more general use of this handsome, hardy, and easily grown tree, which is so attractive a feature in much of nature's grouping. Excellent enlivening effects may also be secured by using the red-twigged dogwood, a shrub some 5 feet high, whose numerous, wine-colored branches contrast finely with evergreens or snow. Owing to its small size this must be grown in front of taller trees, or in nooks such as frequently occur along the edges of an evergreen group. As a companion plant to the dwarf dogwood the golden willow is sometimes used, thereby throwing golden twigs into contrast with those of a crimson hue. The foliage of the golden elder, a hardy, rugged shrub of the very easiest culture, will be of material value during the summer months. This must be planted in full exposure to the sunlight, as the rich yellow foliage becomes greenish in color when grown in partial shade. The coloring of this shrub is finest on young growth; hence it is well to cut back the plant severely in spring. Still another shrub useful for such purposes is the red-bud or Judas tree, whose flowers, in a cheery shade of pink, cover the branches before the leaves appear.

At the base of evergreens occasional touches of color, such as are afforded by beds of petunia, canna, salvia, or other bedding plants, are highly effective and satisfactory. Owing to their vigor of growth and ease of culture clumps of many of the perennial plants are exceedingly valuable adjuncts, used in this way, and if left undisturbed they will increase in size and beauty from year to year. Foxglove, platycodon, hardy phlox, larkspur, and a host of others, from which selection may be made according to the planter's fancy, are available for the purpose. In fact, evergreens form a most excellent background for a great variety of charming hues in flower, fruit, and foliage. During the entire cycle of the seasons they may be made to accentuate and brighten an infinite variety of colors in plants, from the humblest flowers to the gorgeous maples.

For making an evergreen hedge American hemlock or Siberian arbor vitæ are recommended, and, if to be shorn into fanciful shapes, the use of common red cedar, blue-tinted cedar, or any arbor vitæ is advised.

It is urged that "every country home should have its shelter belt of evergreens. Wind-breaks are not meant for the sole use of extensive orchardists, as was once thought, but should be so commonly planted as to protect every home exposed in the least to the ravages of wind and storm. * * *"

As a protection to farm buildings, the barnyard, or poultry run, a good wind-break will repay its cost in a few years in the saving of fuel or feed. The length of time consumed in its growth need not deter anyone from making a wind-break, as results may be secured in half a dozen years by planting thickly, subsequent thinning to be practiced.

For the construction of wind-breaks and shelter belts the white pine, Norway spruce, Austrian and Scotch pines, and American arbor vitæ have no superiors. These kinds all grow rapidly and are not lacking in vigor or adaptability to thin soils, exposed situations, and other adverse conditions.

The authors are careful to warn against the exclusive planting of evergreens about homes.

Deciduous trees occupy a place in any scheme for beautifying lawns which conifers alone do not and can not fill. When surrounded and completely enveloped in a dense growth of evergreens, a style of planting somewhat prevalent a few decades ago, and of which examples are even now occasionally seen, a residence becomes dark, gloomy, damp, and dangerous to health.

NUT GROWING IN MARYLAND.[a]

A recent bulletin of the Maryland Station, by C. P. Close, indicates that the possible area of successful nut culture, even of the choice Persian walnuts and pecans, is much more extended than has generally been supposed. After a thorough investigation of the subject, Professor Close is of the opinion that "there is scarcely any good reason why people who own favorably located, well-drained land without hardpan subsoil in Maryland should not plant nut trees, especially the Persian walnut and pecan," and he predicts that "in a few years Maryland will rank as a nut-producing State. She has the requisite soil, climate, and incentive, and since satisfactory varieties are to be had, it is now only a question of launching the industry systematically, and this movement has already begun."

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[a] Compiled from Maryland Sta. Bul. 125.

Professor Close thinks "the planting of nut trees ought to be encouraged and increased until the nuts are produced in large enough quantities to become a staple article of food instead of only a luxury. They can to a very considerable extent be used in a mixed diet to take the place of meat. At 20 cents per pound for walnuts and 25 cents per pound for porterhouse steak, an equal investment in each will produce about one-fifth more in weight of food material and in energy in the walnuts than in the steak.[a] Pecans rank higher than walnuts in a similar comparison. For use as luxuries only, the addition of thousands of acres of productive nut orchards to our present supply would be profitable."

A nut survey of the State showed that—

> The native black walnut, butternut, hickory, chestnut, beech, hazel, and chinquapin abound almost everywhere. A few of the black walnuts and hickories are of especial merit. * * * Most of the State has produced excellent Persian walnuts and some pecans for more than a hundred years. Only a few named varieties of the improved sorts have thus far been tried. The improved varieties of chestnuts are not generally profitable, but may become so if the immense crop of native chestnuts is cut short, as is now threatened by a disease which is causing the death of hundreds of trees. * * * The Japan walnut is not much grown and is not likely to be.

The following are named as the varieties of Persian walnuts which are believed to be most likely to succeed under Maryland conditions: Chaberte, Franquette, Mayette Blanche, Parisienne, Præparturiens, San Jose, Rush, Norman Pomeroy, Drew, and Peerless Paper Shell.

It is stated that varieties of pecans adapted to Maryland conditions "can not be recommended with as much certainty as can Persian walnuts, because the pecan has not yet received much attention in localities far north of its native home. From the few efforts at pecan growing already made in the State there is reason to believe that the most hardy varieties will succeed here. The following varieties were suggested by Prof. H. H. Hume, who has had considerable experience with pecans in the Southern States: Curtis, Horlbeck, Mantura, Moneymaker, Pabst, Stuart, and Van Deman."

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[a] See U. S. Dept. Agr., Yearbook, 1906, p. 295.

Professor Close describes methods of propagation, grafting, budding, planting, etc., adapted to Maryland conditions. Conditions similar to those of Maryland prevail over extensive areas in which nut culture is now given little attention. The possibility of profitably extending this industry would therefore seem to be worthy of consideration.

"HOGGING OFF" CORN.[a]

"Hogging off" corn "means, in farm practice, turning the hogs into a field of standing corn, allowing them to pull down the stalks and consume the corn at will." In a recent bulletin of the Minnesota Station, D. A. Gaumnitz and associates say:

> This practice was not uncommon twenty or twenty-five years ago in Ohio. It was not followed extensively, because it appeared to be a shiftless, untidy way of harvesting corn, and it was not believed that the hogs made as good gains as when yard fed or closely confined.
>
> These ideas, combined with a plea by agricultural scientists for better farming, which was supposed to mean cutting and carefully husking the corn, led many to discontinue the practice.
>
> About the time this system of hogging corn was discarded in the East, the western farmers took it up, especially in Illinois, Iowa, Kansas, Nebraska, and Oklahoma. Some have followed it more or less since that time with good results.
>
> Corn is a comparatively cheap feed in the central Western States. An acre of corn can be grown up to harvest for from $4 to $5, and with rental of land added, for about $7.50 to $8.50. With fair yields the cost per bushel is very low. High prices for labor, together with low prices for corn, warrant economy in labor even though it may lead to a slight waste of corn.
>
> The idea that hogging off corn is a shiftless way of farming is based neither on facts nor good judgment. So far as the farmer is concerned, the method that yields the largest net profit and the greatest possibility of enjoyment for himself and family is the best to follow. When it is learned that corn may be economically harvested with live stock and that good timothy and clover hay can be produced as cheaply per ton as corn stover can be saved this idea will change.

These conclusions are based upon experiments made at the Minnesota Experiment Station during 1905 and 1906. The hogs were turned into the corn September 19. It is thought that ordinarily they should be turned in by September 1.

> In 1905 the field pigs took to the hogging down of corn rather rapidly, learning to do it in about three days, but in 1906 it required about a week or ten days for the 112-pound pigs to learn how to break down the corn and find the ears.

Hogs thus fed in the fields wasted no more corn than those fed in the yard. In fact, they picked the corn as clean as most men do in husking. The field hogs, moreover, gained nearly one-third more rapidly than those fed in yards and produced pork with less grain.

The experiments indicate that the labor required in caring for hogs is not increased by hogging corn, but may be decreased if systematic methods and a carefully worked out plan with a view to economy of labor and fencing are employed.

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[a] Compiled from Minnesota Sta. Bul. 104.

It is not expected that all corn raised be fed off with hogs, but the amount they can clean up from the time it is nicely glazed until the weather becomes unfavorable (two or three months in Minnesota) may be very economically fed in this way. Hogs should not, as a rule, be turned into more corn at one time than they can eat up clean in two or three weeks. The shorter period is preferable.

Considerable fencing may be necessary, but the cost of this may be from $1 to $2.50 less per acre than the cost of husking the corn. Fields permanently fenced for hogs should, however, be convenient to the farmstead, as large as can be used for the purpose, and of such shape as to reduce to a minimum the amount of fencing necessary to inclose an acre of land, and it is suggested that 3 pounds of rape, costing 15 cents, sown in the corn at the last cultivation, will furnish considerable succulent feed, which may take the place of high-priced shorts.

It is believed that the stover lost in hogging off corn " is in many cases not worth the cost of saving."

Finally, it is said in favor of the practice that " it requires no more labor to prepare for subsequent crop fields that have been hogged off than those that have been treated by the ordinary methods of harvesting."

IMPORTANCE OF LIME AND OTHER MINERAL MATTER IN FEEDING STUFFS.[a]

The importance of protein or nitrogenous material and of energy-yielding fat and carbohydrates in a ration has often been discussed,[b] and it is almost universally conceded that a definite proportion of protein to energy-yielding constituents—that is, a balanced ration—is essential for the best results. For carrying on life processes other constituents—namely, mineral matters—are equally essential, but the question of ash requirement is less generally insisted upon, perhaps owing to the lack of trustworthy information regarding the kinds and amounts which are essential and the many difficulties attendant upon experimental work along such lines.

Everyone concedes that mineral matter is required for the formation of bones, teeth, and other hard parts of the animal body, and that the various digestive juices, the blood, and other portions of the animal must contain certain mineral constituents in order that their proper functions may be carried on. While opinions differ as to some mineral constituents, the following substances are regarded as essential: Calcium and magnesium phosphate, together with small amounts of carbonates, fluorids, and chlorids, which are present in bones and teeth, and chlorids and hydrochloric acid contained in the gastric juice. Potassium compounds are found in saliva and gastric juice and other secretions, iron in the blood and tissues, and sulphur and phosphorus in the blood, brain, and other organs and tissues, while iodin is present in a small amount in the thyroid gland.

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[a] Compiled from Hawaii Sta. Bul. 13; Transvaal Agr. Jour., 5 (1907), Nos. 19, pp. 647-656; 20, pp. 925-928; 6 (1907), No. 21, pp. 51-65.

[b] See, for instance, U. S. Dept. Agr., Farmers' Buls. 22, 170.

Practically all feeding stuffs contain a variety of ash constituents, vegetable products being the most important source of mineral matter, as they are the principal food supply of domestic animals. Under usual circumstances it is believed that the mixed rations which are most commonly fed will supply the needed mineral matter.

The plants obtain the mineral constituents necessary for their growth from the soil, the proportion of different ash constituents varying in the different plant organs. Prof. H. Ingle, of the Transvaal department of agriculture, in a discussion of this question, states that—

> The functions which are filled by the various mineral ingredients are not well known, but they appear to be closely related to the physiological processes by which starch, sugar, albuminoids, and other important products are formed and moved in the plant.
>
> In the most important act of a plant's life—the formation of seed—a concentration of these ash constituents, as well as of the nitrogenous and carbonaceous materials, from the leaves and stems to the seed takes place, in order that the seed may contain a store of plant food to start the seedling when germination occurs.
>
> In this concentration it generally happens that phosphoric acid and potash are stored in largest amount, while lime, magnesia, chlorin, and the other ash constituents, though always present, are there in very small proportion. As a rule, the leaves and stems of a plant contain a higher proportion of these latter elements than the seeds. * * *
>
> Cereals are remarkable for the low proportion of lime to phosphoric acid contained in both their seed and straw. Leguminous plants—e. g., lucern, clover, peas, and beans—contain a high proportion of lime in their leaves and stems. * * * In the straw of cereals and of grasses silica is often the largest constituent, while in leguminosæ and in roots it is present in very small quantity. * * *
>
> Lime and phosphoric acid are required for the formation of bones in animals in the proportion of about 1.5 of lime to 1 of phosphoric acid, and in all probability these are the proportions in which these constituents should be present in the rations of the animals in order to give the most favorable conditions for healthy growth. Animals require for their proper growth supplies of chlorids, fluorids, iron, and probably other substances which may not be present in sufficient quantity in their food.

To cite an instance of the important bearing of ash constituents upon animal production, it seems more than probable that the unsatisfactory results which follow the exclusive feeding of corn to pigs are not due entirely to a deficiency of protein, as is sometimes claimed, but to a lack of ash constituents. When corn is supplemented by some concentrated feed, such as blood meal, tankage, or alfalfa hay, the ash content of the ration is increased, as well as the protein, and there is reason to believe that the improvement noted is in considerable measure to be ascribed to the increased supply of mineral matter.[a]

To cite another instance, the blue-grass region of Kentucky has long been said to possess peculiar advantages for raising farm animals, particularly horses. In so far as this advantage depends upon feed, it seems likely that it is due to the abundance of lime in the forage crops grown upon the characteristic limestone soil of the blue-grass region.

That the character of the feed and its value for farm animals is dependent in considerable degree upon the mineral character of the soil, and particularly upon the lime content, is clearly shown by the recently published studies of local-grown feeding stuffs, particularly those belonging to the grass family, carried on at the Hawaii Station. In the volcanic soil of the Hawaiian Islands there is little lime, and an examination of the ash constituents showed that Hawaiian forage crops were uniformly deficient in lime, and that the failure to obtain best results which has been noted with an apparently well-balanced ration may be attributed to this cause. In order to secure the best results in bone development, health, etc., Dr. E. C. Shorey, who carried on the studies referred to, believes that these Hawaiian feeding stuffs deficient in lime should be supplemented by others richer in this constituent, such as leguminous plants and sugarhouse by-products, or by the use of some lime in drinking water, mixed with the feeds used, or applied to the soils producing the forage crops.

In connection with Professor Ingle's work, to which reference has already been made, a large number of analyses showed that many of the feeding stuffs grown in the Transvaal were deficient in lime in proportion to phosphoric acid, and he attributes diseases and lack of thrift, often noted in mules and horses, to the fact that the feeding stuffs most commonly used (corn and oat hay) do not provide lime in sufficient amount or in the right proportion to phosphoric acid.

> The usual rations of horses and mules in South Africa are made up of oat hay or oat hay and mealies [Indian corn], and * * * both these foodstuffs contain far too much phosphoric acid in proportion to lime for the probable requirements of animals for healthy bone formation. In Europe and most other parts of the world where oats are used as food for draft animals meadow hay or clover hay is given in addition, and thus the ratio of phosphoric acid to lime in the whole ration is greatly diminshed. * * *

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[a] U. S. Dept. Agr., Farmers' Buls. 169, p. 29; 276, p. 21.

> The practical deductions to be drawn * * * are that the susceptibility to bone disease in horses, mules, and donkeys [noted in the Transvaal] would be greatly diminished if the present exclusive diet of oat hay or oat hay and mealies were replaced, to some extent at least, by lucern hay, or probably even veld hay, and that a recognition of the need of supplying bone-forming materials—lime and phosphoric acid—in proper proportions in framing rations for animals would undoubtedly lead to greater success in producing sound and healthy stock than at present attends the usual methods of feeding adopted in this country. * * *
>
> Bran and linseed cake, which are rich in ash and therefore generally regarded as being particularly useful in supplying the materials for bone formation, are, from the point of view here explained, particularly unsuitable for this purpose because of the large proportion of phosphorus pentoxid to lime which they contain. The injury to the bones of animals fed largely upon bran has been noticed in the diseases known as "bran rachitis," or "miller's horse disease," and in some respects the effects produced resemble osteoporosis.

As another instance of an attempt to supply a deficiency in mineral matter may be mentioned the custom of feeding broken or crushed bone to cattle as practiced in South Africa. In experiments reported by D. Hutcheon,[a] crushed dried bone about the size of coarse oatmeal, when fed to a steer at the rate of about 1 pound per day for seven days, was apparently completely digested, none of the bone being recovered in the excreta.

Many European investigators have studied the relation of phosphorus and calcium compounds for various farm animals, particularly noteworthy work being that of Gouin and Andouard with calves. The consensus of opinion seems to be that an addition of mineral constituents to the ration is desirable if for any reason enough is not supplied by the ordinary feeds. The deficiency may be made good by the selection of feeding stuffs containing the desired mineral elements in greater abundance or by supplying mixtures of mineral salts, though the advantages of the latter method are perhaps less clearly demonstrated. It will be recalled, however, that such a use of mineral salts is in accord with general agricultural practice, salt, sulphur, wood ashes, and similar material being very commonly given to live stock on many farms.

According to Professor Ingle—

> The use of "bone flour" or "bone meal" as a "lick" for cattle in districts in which the soil is deficient in lime, and in which certain bone diseases are prevalent, is much advocated in many quarters, and would appear to be useful. Bone ash would probably be preferable, and its use would avoid the danger of spreading disease which exists when raw bones are employed. Although bones or bone ash contain lime and phosphoric acid in exactly the same proportions that they are required in the building up of the bones of the animals fed upon them, it would seem better to provide a food in which the proportion of

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[a] Agr. Jour. Cape Good Hope, 28 (1906), No. 2, pp. 210–212.

lime to phosphoric acid is higher, since the object in view is to amend the too low ratio which exists in the actual food of the animal. * * *

The supply of common salt is absolutely essential, and in districts where this substance does not occur in the soil or water, it is advisable to supply it to animals in the form of "lick." The addition of lime or of bone meal to the "lick" may also be useful, though it is probable that these substances as "lick" are not so effective as when they form actual constituents of the food plants. The same applies to sulphur, which is also often added to "licks." It should be pointed out, however, that, in addition to supplying the physiological requirements of the animals, salt, sulphur, and other additions sometimes made to the "lick" act medicinally, sometimes as vermifuges, sometimes as purgatives. This aspect of the question, however, can not appropriately be discussed here.

Studies of the ash content of farm crops have been an important feature of experiment station work in this country, but the question has been studied more often from the standpoint of the plant's draft upon the soil and hence its fertilizer requirements than from that of the value of the ash as a food material. The latter question would seem to be of sufficient importance to warrant more careful study.

PREPARATION OF MISCIBLE OILS.[a]

The use of refined and crude oils as insecticides for scale insects and other insect pests has been quite generally adopted among orchardists for many years. The efficiency of these oils in destroying insects is well known, but when used at too great a strength they may injure fruit trees, especially if applied during the growing period or for many years in succession during the dormant season. It is, therefore, a matter of much practical importance to devise means of mixing oils with water so that they may be diluted as greatly as is consistent with efficiency. The mechanical mixture of oils with water by means of special machinery has not given satisfactory results. Resort has, therefore, been had to different methods of preparing emulsions, ordinary kerosene emulsion being the most familiar example of this sort of mixture.

In order to get satisfactory results from kerosene emulsion it is necessary to use a preparation carrying about 20 per cent of oil. This, however, appears to be too high a percentage of oil for safety in continued use on fruit trees. Recently much interest has been aroused in improved methods of preparing a miscible oil by emulsifying heavy or crude oils. A number of proprietary mixtures of this sort have been put on the market and have given reasonable satisfaction, but are too expensive. In view of the importance of the matter,

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[a] Compiled from Delaware Sta. Bul. 75; Circ. 1; New Jersey Stas. Rpt. 1904, p. 644; 1905, p. 615; 1906, p. 587; Pennsylvania Sta. Bul. 86; U. S. Dept. Agr., Farmers' Bul. 127.

Prof. C. L. Penny, formerly of the Delaware Station and now of the Pennsylvania Station, has devoted a great amount of attention to devising a good method for emulsifying heavy oils. The method as worked out by Professor Penny is briefly as follows: In the preparation of a soap solution to be used as an emulsifier 10 gallons of menhaden oil, 8 gallons of carbolic acid, and 15 pounds of caustic potash are heated in an iron kettle or some other kind of cooking apparatus to a temperature of 290° or 300° F. The mixture is stirred at first to prevent the potash from caking on the bottom of the kettle. As soon as the required temperature is reached heating is discontinued and 2 gallons of kerosene are added at once. As soon as the temperature of the mixture falls below 212° F. 2 gallons of water are added. The mixture is then well stirred, and constitutes the soap solution or emulsifier. This solution pours readily at all temperatures above the freezing point. It does not deteriorate if kept over from one season to another.

The soap solution or emulsifier is then used for emulsifying a suitable quantity of oil. The emulsifier may be used in making a miscible oil with kerosene or crude petroleum. A considerable variety of formulas have been tested by Professor Penny, but the one which gave the best results called for 40 gallons paraffin oil and 6 gallons of rosin oil for each 3⅔ gallons of the soap solution. A small amount of water, which appears to vary slightly according to the quality of the materials used, is added in every case as required by test. Professor Penny has found that the addition of water assists in perfecting the emulsion. If after the soap solution and oils have been mixed there is a tendency to separate to some extent into two layers, the addition of a gallon, more or less, of water may produce a perfect emulsion.

The third stage in the preparation of miscible oils for spraying is the dilution of the miscible-oil mixture just described with water before applying to the trees. If the formulas mentioned above are adopted, 1 gallon of the emulsifier will make from 8 to 14 gallons of miscible oil, and this quantity in turn will make from 100 to 210 gallons of diluted emulsion ready to apply to fruit trees. In an iron kettle large enough to boil 30 gallons of the soap solution enough of this material can be prepared at one boiling to produce 4,000 gallons or more of emulsion upon dilution. The diluted emulsion appears to be efficient in the destruction of scale insects if it contains 10 per cent or even less of oil. The cost of such a spraying material is about 1 cent per gallon as compared with one-half to 1 cent for lime-sulphur.

If any trouble should be experienced in obtaining a perfect em sion before the final dilution with water, Professor Penny rec mends that the amount of water should be varied, and that if t does not give the desired result the amount of rosin oil should reduced. As a last resort the amount of soap may be increased. soon, however, as the proper proportions are determined for particular grade of materials no further trouble should be exp enced.

The chief advantages of miscible oils over other insecticide use in scale insects are their relative harmlessness when comin contact with workmen and apparatus, and also the fact that are always ready for use without the further application of If the individual fruit raiser should not think it advisable to vide a suitable apparatus, it has been suggested that the soap sol might be prepared at a central point for shipment to the fr growers of the neighborhood.

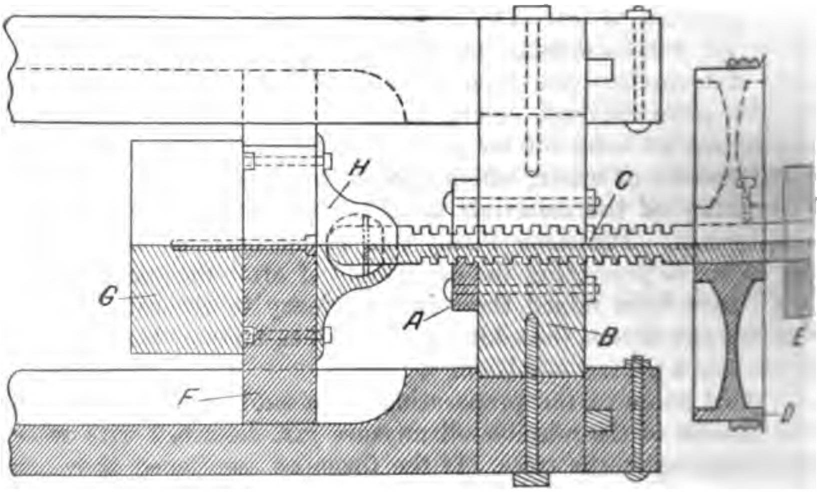

FIG. 3.—The self-acting parts of an automatic cheese press.

AN AUTOMATIC CHEESE PRESS.[a]

Various presses designed to secure continuous pressure and insure a well-closed cheese are on the market, but in the cour investigations on cheese making carried on by J. W. Moore, of Wisconsin Station, in cooperation with the Dairy Division of Department, it was found desirable to modify the ordinary for of presses in order to maintain automatically a constant pressur any desired length of time. The construction of the form of p adopted is shown in cross section in figure 3.

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[a] Compiled from Wisconsin Sta. Rpt. 1907, p. 207.

threaded nut (A) is set into the crosspiece (B) at the end of the press. :rew (C), taken from an old vertical cheese press, works through the nut the crosspiece. A pulley (D) is attached rigidly to the screw (C) near its ·r end.

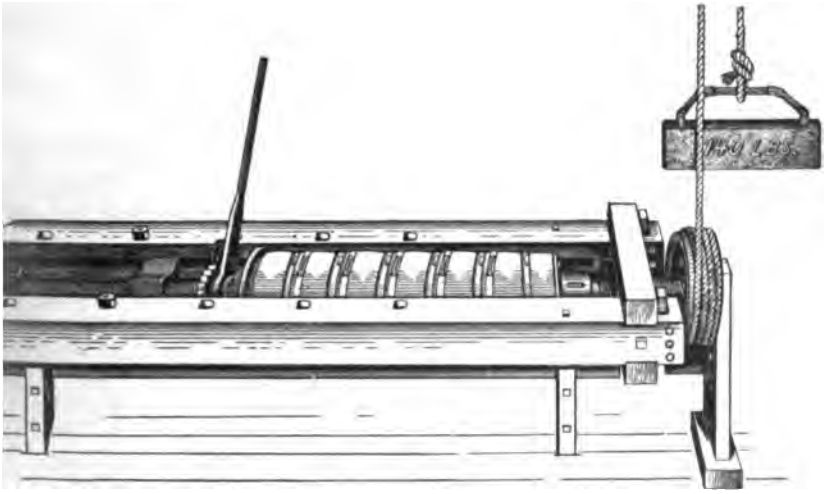
ne journal (E) is set in a plank fastened to the floor; the other end of the w fits into a swivel (H) which presses against the guide (F).

he head block (G) is attached to the guide (F) by means of a lag screw. screw (C) is 1⅜ inches in diameter and has three coils of thread to the ı. The pulley (D) is 13 inches in diameter.

he guide slides forward in the grooves when the pulley is turned.

rope, wrapped several times around the pulley, passes through a small ey fixed to a beam overhead. Weights are attached to the rope to produce desired pressure on the cheese in the press. (Fig. 4.)

n several months' tests of the press cheeses were taken from it ly which were uniformly free from mechanical openings, a quality ired by every cheese maker.



G. 4.—Automatic cheese press. The 140-pound weight attached to a rope passing over a pulley attached to the ceiling of the room moves the screw which keeps the pressure constant.

" The results of several months of experimenting indicate that ›out 48 pounds per square inch on the end of the cheese is sufficient › close any curd, even if very firm, provided that it has been prop-·ly handled before pressing."

The advantages of using such a press in the ordinary American 'heddar cheese factory are in brief as follows: By its use " the ıeese can be put under any required pressure. By insuring con-ınuous pressure during the night the cheeses are more perfectly losed than is otherwise possible. When the continuous-pressure evice is used there is less loss of fat, because a lower pressure is pplied to the warm curd than is required with the ordinary press."

CANE SUGAR AND BEET SUGAR FOR CANNING AND JEL MAKING.[a]

Chemists generally concede that the sugar which occurs in the cane is identical from the standpoint of chemical compositi structure with that found in the sugar maple, sugar beet, and other vegetable products. As it occurs in nature, the sugar is panied by various other materials dissolved in the plant jui it is the presence of more or less of such bodies which gives commercial sugar products, like molasses and maple sirup, the tinctive flavor.

Old-fashioned brown sugar, maple sugar, crude beet sugar, nut sugar, and other similar sugars differ in appearance, flavo palatability, owing to the character of the plant products wh main with the sugar, but from all of them it is possible to pure, colorless crystals, like those called rock candy, identi appearance, flavor, and other characteristics. If the crystals ar and separate, we have granulated sugar, while if they adhere to in large masses, lump sugar, cube sugar, or loaf sugar results.

The cane-sugar industry is much older than the beet-sugar ind and since the days when the latter first assumed commercial impor there has been more or less popular discussion regarding the tity of the sugar from these two sources and regarding the rel merits for household purposes of the two sorts as they are foun the market.

It has often been said that beet sugar is not as sweet as cane notwithstanding the fact that chemists have known that, pro the two sorts of sugar are of equal degrees of fineness of granul and hence alike as to the ease or quickness with which a given tity will dissolve, there is no difference in sweetness, for in when a spoonful is added to a cup of tea.

Another common statement is that beet sugar can not be successfully for canning, jelly making, and preserving. In ear times, before methods of refining had been perfected, there ma been some warrant for such a belief, but methods of purifyi sugar were long ago perfected and such sugar has been us many years in this country and Europe for all household pur

In this connection, tests recently carried on at the Cal Experiment Station by G. W. Shaw, in which beet sugar and sugar were compared under factory and domestic conditio preserving, are of interest.

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[a] Compiled from California Sta. Circ. 33, p. 4.

The fruits used in the tests, carried out on a commercial scale, were cherries, apricots, plums, peaches, and pears. Each of these was preserved in sirup of different strength by the usual methods. In making the sirups used with the fruit some differences in the action of different grades of sugar were noted.

The beet sugar caused the more froth in the making of sirup, but further investigation led to the conclusion that this was due to the fact that the granulation of the beet sugar was much finer than that of the cane, therefore causing more air to become entangled during the stirring than in the case of the sugar from cane. This was shown by the use of cane sugar of about the same granulation in another batch of sirup, in which case the same frothing occurred as with the beet product. This has been noted in other instances, and canners are wont to count this against the beet sugar, but it is only the result of not comparing sugars of the same granulation. This difference in the action due to difference of granulation was the only apparent difference arising during the making of the sirup. This is not an essential difference between these sugars, however, as the character of the granulation is entirely dependent upon the wish of the manufacturer, the methods of boiling and granulation being the same in both cases. The sugar ordinarily used by the canners is known as dry, coarse, granulated—a grade which is not commonly made by the beet-sugar manufacturers, because there has not yet been the demand sufficient to warrant its production, but it could be made by them as readily as the ordinary granulation. After canning, the fruits were stored in cases in the ordinary way, the cans being opened from time to time to determine whether any change had taken place. Of the 2,000 cans which were thus treated only 6 cans from the beet-sugar lot and 7 from the cane-sugar lot spoiled during the two years, and these were evidently due to imperfect sealing of the cans, thus showing the utter lack of foundation for the idea that fruits do not keep well when preserved with beet sugar and that such sugar does not work well in the cannery.

In the household trials 40 per cent sirup was used and the fruits were put up in ordinary glass jars, 50 jars of both apricots and peaches being canned. "From these not a single can spoiled during the two-year period." The two sorts of sugar gave equally good results.

For the jelly-making trials apples and currants were selected, equal quantities of juice and sugar, either beet or cane, being used and the mixture boiled until of the right consistency to jelly. "The product in each case was as clear as it is possible for jelly to be, and not the slightest difficulty was experienced in the making of it."

In connection with the experimental tests an attempt was made to trace numerous reports to the effect that fruit had been lost through the use of beet sugar in canning, but in no instance was this found to be the case, though numerous letters were received in reply to inquiries which were sent out.

The utter folly of this idea that beet sugar can not be used for canning purposes is further emphasized by the fact that practically all the sugar used in

Germany and France for the purposes of canning and preserving is from th beet, and for many years American refined beet sugar was used without co plaint in this country, because the mass of the people were not aware th was derived from the beet. This sugar was brought here as raw sugar fr Europe and refined at American refineries.

Professor Shaw concludes from his experimental data and evidence that under both commercial and household conditions sugar and cane sugar give equally satisfactory results for cann fruit and also for jelly making.

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Issued July 29, 1908.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 330.

DEER FARMING IN THE UNITED STATES.

BY

D. E. LANTZ,
Assistant, Biological Survey.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., June

SIR: I have the honor to transmit the accompanying manuscrip the subject of Deer Farming in the United States, and to recom its publication as Farmers' Bulletin No. 330. As a result of growing scarcity of game animals in this country the supply of ve son is wholly inadequate to the demand, and the time seems oppor for developing the industry of deer farming, which may be m profitable alike to the State and the individuals engaged therein. T raising of venison for market is as legitimate a business as the gr ing of beef and mutton, and State laws, when prohibitory, as many them are, should be so modified as to encourage the industry. F thermore, deer and elk may be raised to advantage in forests and rough, brushy ground unfitted for either agriculture or stock rais thus utilizing for profit much land that is now waste. An ad advantage is that the business is well adapted to landowners small means.

Respectfully,

C. HART MERRIAM,
Chief, Biological Sur

HON. JAMES WILSON,
Secretary of Agriculture.

DEER[a] FARMING IN THE UNITED STATES.

INTRODUCTION.

The present bulletin discusses briefly the economic possibilities of raising deer and elk in the United States. It is believed that when the restrictions now imposed by State laws are removed this business may be made an important and highly profitable industry, especially since it will be the means of utilizing much otherwise unproductive land. The raising of venison should be, and is naturally, as legitimate a business as the growing of beef or mutton, and State laws should be so modified as to permit the producer, who has stocked a preserve with deer at private expense, to dispose of his product at any time, under reasonable regulations, either for breeding purposes or for food.

The growing scarcity of game mammals and birds in the United States and the threatened extinction of some of them over large parts of their present ranges make the preservation of the remnant highly important. Very important also is the increase of this remnant so as to make game once more abundant. It is believed that by means of intelligent game propagation, both by the States and by private enterprise, many of our depleted ranges can be restocked with big game.

IMPORTANCE OF THE DEER FAMILY.

The members of the deer family (Cervidæ) rank next to the cattle and sheep family (Bovidæ) in general utility, and are the most important of the big game animals of America.

Wherever obtainable in quantity the flesh of deer of different kinds has always been a staple article of diet, and under present market conditions it is hardly necessary to say that venison is perhaps the most important game, being a favorite with epicures and also having a wide use as a substitute for beef and mutton, which meats it resembles in texture, color, and general characteristics. Its flavor

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[a] The term "deer" is here used in its general sense, in which it includes the elk, the reindeer or caribou, the moose, and other species, besides those usually referred to as deer.

is distinctive, though it suggests mutton rather than beef. In ch
ical composition it is very similar to beef, though, judging fr
available data, it is not so fat as stall-fed cattle. The follow
figures show how it compares with beef and mutton: A lean ven
roast before cooking has been found to contain on an average 75 p
cent of water, 20 per cent of protein or nitrogenous material, an
per cent of fat; a lean beef rump, some 65 to 70 per cent of water,
to 23 per cent of protein, and 5 to 14 per cent of fat; and a lean le
of mutton, 67 per cent of water, 19 per cent of protein, and 13 p
cent of fat.

Venison, beef, and other common meats are very thorou
digested, whatever the method of cooking. Venison may be roa
broiled, pan-broiled, or used for making stews, in much the sa
way as beef. Venison, particularly steak, to be at its best, shoul
eaten as soon as possible after it is cooked.

The general popularity of venison is so great and the dem
for it so widespread that overproduction is improbable. The o
products of the deer—skins and horns—are of considerable imp
tance, and in countries where deer are abundant and especially w
large herds are kept in semidomestication, the commerce in bot
very extensive.

THE DOMESTICATION OF DEER.

A number of species of the deer family have been proved to
susceptible to domestication. The reindeer, however, is the only o
that has been brought fully under the control of man. The fa
that the European red deer and the fallow deer have been bred
parks for centuries without domestication does not prove that th
are less susceptible to the process than the reindeer. The purpo
for which they have been held captive and the environment giv
them have been markedly different. It must be remembered, al
that few attempts have been made to rear and domesticate deer un
intelligent management. The work has been largely a matter
chance experiment. If they had been as long under careful manage
ment as cattle, they would now, probably, be equally plastic in t
hands of the skillful breeder.

But raising deer for profit does not necessarily imply their co
plete domestication. They may be kept in large preserves w
surroundings as nearly natural as possible and their domestica
entirely ignored. Thus the breeder may reap nearly all the pr
that could be expected from a domestic herd, while the anim
escape most of the dangers incident to close captivity. But t
breeder who aims at the ultimate domestication of the animals, a
whose herd approaches nearest to true domesticity, will in the e
be most successful.

SPECIES TO BE SELECTED FOR BREEDING.

The number of species of deer suited for breeding in inclosures in the United States is great, though the chances for success are by no means the same for all. As a rule those native to America are to be preferred, since they are already acclimated. In selecting any species, similarity between its natural habitat and that to which it is to be transferred must be considered. Important, also, is its adaptability to varied conditions, as shown by former attempts to acclimatize it.

Unless they have shown a peculiar adaptability to such change, deer should not be taken from arid parts of the United States to humid parts. To a disregard of this principle are probably due many of the failures that have attended experiments in breeding the American antelope, the Columbia blacktail deer, the moose, and other animals in places differing widely from their natural ranges.

The history of attempts to acclimatize the several kinds of deer shows that some readily adapt themselves to a great variety of conditions, and efforts to introduce them into new countries have been almost uniformly successful. Such has been the experience with the axis deer, the Japanese and Pekin sikas, the red and the fallow deer of Europe, and especially with the wapiti, or Rocky Mountain elk, and the Virginia deer. While experiments with the foreign species named offer every promise of success to the owners of American preserves, there are obvious reasons for recommending the two native animals just mentioned as best suited for the production of venison in the United States.

THE WAPITI, OR ROCKY MOUNTAIN ELK.

The wapiti (*Cervus canadensis*), including two related species and a geographic race, and known generally in America as the elk, is, next to the moose, the largest of our deer. It was once abundant over the greater part of the United States, whence its range extended northward to about latitude 60° in the Peace River region of the interior of Canada. In the United States the limits of its range eastward were the Adirondacks, western New Jersey, and eastern Pennsylvania; southward it reached the southern Alleghenies, northern Texas, southern New Mexico, and Arizona; and westward the Pacific Ocean.

For the practical purposes of this bulletin all the forms of the wapiti are treated as a single species. At the present time the range of these animals has so far diminished that they occur only in a few scattered localities outside of the Yellowstone National Park and the mountainous country surrounding it, where large herds remain. Smaller herds still occur in Colorado, western Montana, Idaho, east-

ern Oregon, Manitoba, Alberta, British Columbia, and the
mountains of Washington, Oregon, and northwestern California.
band of the small California valley elk still inhabits the sout
part of the San Joaquin Valley.

The herds that summer in the Yellowstone National Park an
winter spread southward and eastward in Wyoming are said to n

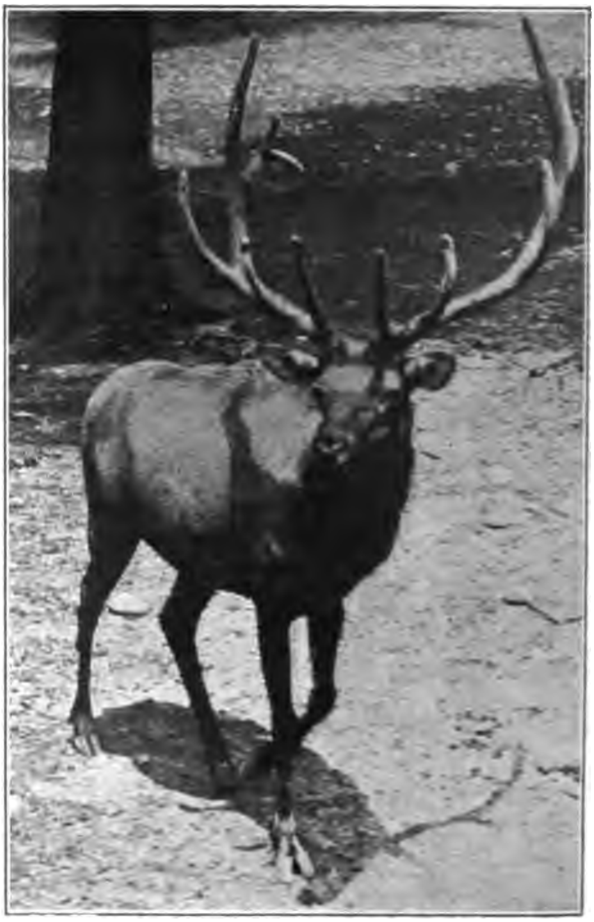

FIG 1.—Rocky Mountain elk.

ber about 30,000 head, and constitute the only large bands of t
noble game animal that are left. Although protected in their s
mer ranges and partially safeguarded from destruction in wi
by the State of Wyoming, there is yet great danger that these her
may perish from lack of food in a succession of severe winters. Par
tial provision for winter forage has been made within the Nati
Park, but the supply is inadequate for the large numbers of anim

Further safeguards are needed to place the Wyoming elk herds beyond the reach of winter starvation.

In addition to the wild herds, there are a considerable number of elk in private game preserves and parks, as well as in nearly all the public zoological parks and gardens of this country. The herds in captivity form the nucleus from which, under wise management, some of the former ranges of this animal may be restocked and from which a profitable business of growing elk venison for market may be developed. At the present time this species affords a most promising field for ventures in breeding for profit.

HABITS OF ELK.

The elk is both a browsing and a grazing animal. While it eats grasses freely and has been known to subsist entirely upon pasture, it seems to prefer a mixture of grass and browse.

The elk is extremely polygamous. The adult bulls shed their antlers annually in March or April, and new ones attain their full size in about ninety days. The " velvet " adheres until about August. While the horns are growing the bulls usually lead solitary lives; but early in September, when the horns are fully matured, the rutting season begins. Fights for supremacy then take place, and the victor takes charge of as many cows as he can round up and control. The period of gestation is about 8½ months. The female does not usually breed until the third year, and produces but one calf at a time.

Although the elk is less prolific than the common deer and some other species that have been bred in parks, it increases fully as rapidly as the common red deer of Europe. Moreover, it makes up for any lack of fecundity by its superior hardiness and ease of management. It has been acclimatized in many parts of the world, and shows the same vigor and hardiness wherever it has been transplanted. In Europe it has been successfully crossed with the Altai wapiti and the red deer, and in both instances the offspring were superior in size and general stamina to the native stock.

ELK VENISON.

The flesh of the elk, although somewhat coarse, is superior in flavor to most venison. That of the bulls is in its best condition about the time the velvet is shed. By the time the rut is over, in October, their flesh is in the poorest condition. As the open season for elk is usually in October and November, and only bulls are killed, it follows that hunters often obtain the venison when it is poorest. The meat is not best when freshly killed, but should be left hanging for four or five days before it is used. Of course fat elk are better eating than lean, and it is said that venison from castrated bulls is superior to any other.

DOMESTICATION OF ELK.

With few exceptions the early attempts to domesticate elk were made by men who were wealthy enough to disregard all thought of profit in raising them. They were usually placed under the care of servants, and the bucks were left uncastrated until they became old and unmanageable. Soon the serious problem of controlling them outweighed the novelty of their possession, and one by one the attempts at domestication were abandoned.

A desire to preserve this important game animal has caused a renewal of attempts to breed it in confinement, and at present there are small herds under private ownership in many places in the United States. The Biological Survey has recently obtained much information from owners of herds in regard to their experience in breeding and rearing the animals, and also their opinions as to the possibility of making the business of raising them profitable. Of about a dozen successful breeders,[a] nearly all are of the opinion that raising elk for market can be made remunerative if present laws as to the sale of the meat are modified.

One especially important fact has been developed by the reports from breeders. It is that the elk readily adapts itself to almost any environment. Even within the narrow confines of the paddocks of the ordinary zoological park the animal does well and increases so that periodically the herds have to be reduced by sales.

The fullest reports that have been received by the Department of Agriculture from breeders of elk are from George W. Russ, of Eureka Springs, Ark., through H. N. Vinall, of the Bureau of Plant Industry.

Mr. Russ has a herd of 34 elk. They have ample range in the Ozarks on rough land covered with hardwood forest and abundant underbrush. The animals improve the forest by clearing out part of the thicket. They feed on buds and leaves to a height of 8 feet, and any growth under this is liable to be eliminated if the range is restricted. If not closely confined, elk do not eat the bark from trees, nor do they eat evergreens. In clearing out underbrush from thickets they are more useful than goats, since they browse higher. Goats, however, eat closer to the ground; and as the two animals get along well together, Mr. Russ recommends the use of both for clearing up brushy land and fitting it for tame grasses.

The increase of elk under domestication is equal to that of cattle. Fully 90 per cent of the females produce healthy young. An adult male elk weighs from 700 to 1,000 pounds; a female, from 600 to 800 pounds. The percentage of dressed meat is greater than with cattle, but, owing to hostile game laws, experience in marketing it is very limited. An offer of 40 cents a pound for dressed meat was received from St. Louis, but the law would not permit its export. Mr. Russ says:

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[a] The experiences of these breeders are, in the main, reserved for a more extended bulletin on the domestication of game mammals.

> From the fact that as high as $1.50 per pound has been paid for this meat in New York City and Canada, and that the best hotels and restaurants pronounce it the finest of all the meats of mammals, we are of the opinion that if laws were such that domesticated elk meat could be furnished it would be many years before the supply would make the price reasonable compared with other meats. Elk meat can be produced in many sections of this country at less cost per pound than beef, mutton, or pork.

Mr. Russ thinks that large areas of rough lands in the United States not now utilized, especially in localities like the Ozarks and the Alleghenies, could be economically used to produce venison for sale, and he regards the elk as especially suited for this purpose.

Another feature of Mr. Russ's report is of more than passing interest. He says:

> We find from long experience that cattle, sheep, and goats can be grazed in the same lots with elk, providing, however, that the lots or inclosures are not small: the larger the area the better. We know of no more appropriate place to call attention to the great benefit of a few elk in the same pasture with sheep and goats. An elk is the natural enemy of dogs and wolves. We suffered great losses to our flocks until we learned this fact; since then we have had no loss from that cause. A few elk in a thousand-acre pasture will absolutely protect the flocks therein. Our own dogs are so well aware of the danger in our elk park that they can not be induced to enter it.

Judge Caton, in his Antelope and Deer of America, also remarks on the animosity of elk toward dogs, and says that the does always lead in the chase of dogs that get into the elk park. If elk will attack and vanquish dogs and coyotes and thus help to protect domestic animals grazing in the same pastures, a knowledge of the fact may be of great advantage to stockmen who desire to give up herding sheep and to resort to fenced pastures instead. The addition of a few elk in the pasture may be an efficient protection from dogs, coyotes, and wolves. However, outside of fenced pastures elk do not always show themselves hostile to dogs and coyotes.[a]

MANAGEMENT OF ELK IN INCLOSURES.

Lorenzo Stratton, of Little Valley, Cattaraugus County, N. Y., began experiments in breeding elk about sixty years ago. His plan of management consisted essentially in taming the calves when very young and continuing the petting process with the entire herd. He visited the animals daily in the pasture and always carried dainties to feed them. As the bulls became old and developed signs of viciousness, they were castrated, younger animals being used for breeding. He thus developed a thoroughly domesticated herd.

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[a] President Roosevelt reports in Outdoor Pastimes of an American Hunter that he saw a coyote walking unnoticed among a band of elk in Yellowstone Park; and Thomas Blagden, of Washington, D. C., informs the writer that noisy dogs were used to drive unconfined elk from the lawns of summer cottages at Saranac Inn, in the Adirondacks.

For economic reasons, it is not always possible to follow Mr. Stratton's plan. Those who grow the animals for venison and in large preserves would find it impracticable to tame all the calves. However, if elk or deer are grown for stocking parks or private preserves, the tamer they are the easier it will be to handle and ship them.

Range.—In choosing a range for elk, the natural food supply is important. They thrive best in preserves having a variety of food plants—grasses, bushes, and trees. Rough lands, well watered with clear streams and having some forested area, are well adapted to their needs. About as many elk can be kept on such a range as cattle on an equal area of fair pasture. There should be thickets enough to furnish winter browse, but this should be supplemented by a supply of winter forage.

Food.—Except when deep snows cover the ground, elk will keep in good condition on ordinary pasture and browse; but a system of management that provides other food regularly will be found more satisfactory. Hay and corn fodder are excellent winter forage; but alfalfa hay has proved to be the best dry food for both elk and deer. A little oats or corn—whole or chopped—may be fed each day. Elk are fond of corn, and feeding it affords excellent opportunities for winning their confidence and taming them. The same may be said of salt, which should be furnished liberally to all deer kept in inclosures. Running water, although not essential, is of great importance in maintaining elk in good condition.

Fence.—Elk are much less nervous than ordinary deer, and less disposed to jump fences. When they escape from an inclosure they usually return of their own accord. If tame, they may be driven like cattle. Ordinarily, a 5-foot fence of any kind will confine elk. Henry Binning, of Cora, Wyo., writes us that a 4-foot woven-wire fence is ample for these animals. A small inclosure in which a vicious bull elk is to be kept should be higher and of stronger material. Mr. Russ's report, already partly quoted, states that where lumber for posts is cheap a good elk fence may be built for $200 a mile. But the actual cost will, of course, vary greatly according to style, price of labor, nearness to market, and other circumstances.

Cost of stock.—The cost of stocking an elk preserve is not great. Usually surplus stock from zoological parks or small private preserves may be obtained at low cost, varying with the immediate demand for the animals. At times they have sold for less than $20 a head, and with the present restrictions on sale, low prices are likely to continue. A few years ago T. J. Wilson, of Lewisburg, Ohio, paid $165 for three animals. A Michigan breeder recently offered to deliver a dozen head, sex and age not given, all fine specimens, for $500. This is, of course, a low price, not more than cattle would bring and less than the venison would be worth if it could be sold. If restrictions on the sale and shipment of venison from private preserves were removed, prices of the stock would, of course, soon advance, and necessitate a greater outlay in starting the business.

Vicious male elk.—The male elk is ordinarily docile, but in the rutting season the older ones often become ill-tempered and dangerous. Several tragedies connected with attempts to domesticate elk are matters of history. One was recorded by Judge Caton in his Antelope and Deer of America as having occurred in his own park. Another took place at Bull City, Osborne County, Kans., in October, 1879, and resulted in the instant death of Gen. H. C. Bull, the mortal wounding of two other men, and the serious injury of another, from the attacks of an infuriated bull elk that had previously been regarded as extremely gentle.

Wild and unconfined deer and elk flee from man under nearly all circumstances, but when wounded and closely pressed they have been known to attack hunters. It is unlikely that, even in the rutting season, a wild bull elk would attack a human being. But the tame or partially tame animals that have become familiar with man are to be feared and should not be approached in that season without extreme caution. A male elk or deer that has once shown viciousness can not again be trusted.

The remedy for viciousness in the male elk is castration. It is unsafe to keep an uncastrated male elk over 4 years old, unless he is in a strongly fenced inclosure from which visitors are excluded. The effects of castration are to make the animal docile and to greatly enhance his value for venison. This is in accord with observed results in the production of beef, pork, and mutton. Venison grown in domestication under a system in which the male animals intended for slaughter are castrated should be uniformly of the highest grade and far superior to that obtained in the wild state during the usual open season for hunting. This consideration is of the greatest importance in fixing the final status of venison grown under domestication.

BREEDING THE VIRGINIA DEER.

The Virginia, or whitetail, deer (*Odocoileus virginianus*) is the common deer of the United States. Including the half dozen geographic races that occur within our borders, it is distributed over most of the country, except Nevada and the major portions of Utah, Arizona, Washington, Oregon, and California. It is ex Delaware and practically so in a number of States in the M West. South of our borders a number of closely related occur.

In view of the wide natural range of the whitetail deer, its ability to nearly all sections of the United States can not be Testimony as to its hardiness in parks and preserves is not mous as that concerning the wapiti: but the general experie breeders is that with suitable range, plenty of good water, and r

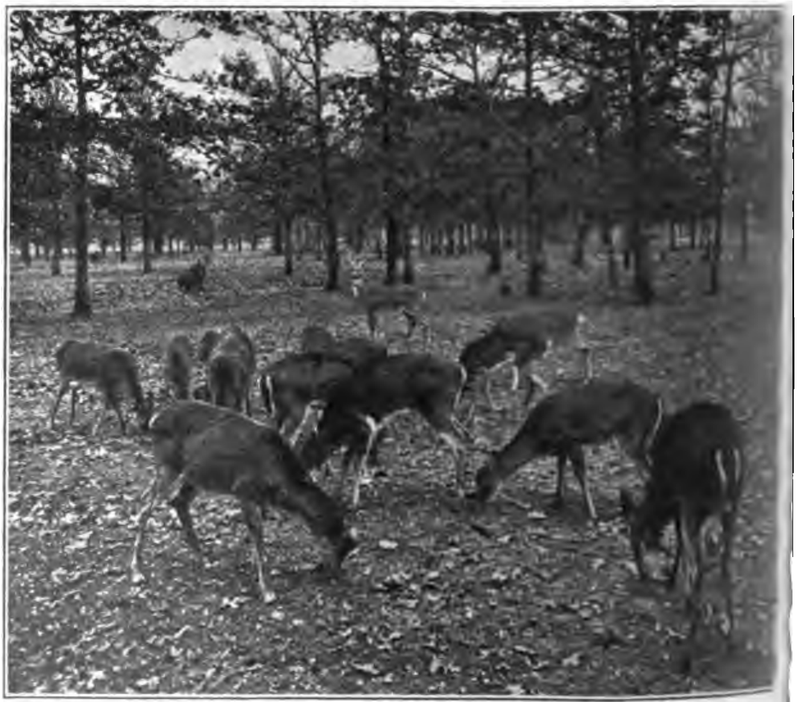

Fig. 2.—Herd of domesticated Virginia deer belonging to R. H. Harris, Clark

able care in winter, raising this deer for stocking preserves or venison may be made as profitable as any other live-stock indus Not only do deer thrive on land unsuited for cattle or horses, like elk, they may be raised to great advantage in brushy or timbered pastures fully stocked with cattle or horses, as the food of deer includes grass.

Advocates of the Angora goat industry state that within the Unit States there are 250,000,000 acres of land not suited to tillage or the pasture of horses, cattle, or sheep, which are well adapted to Much of this land is suited also to deer and elk, and can be utiliz these animals with less injury to the forest cover than would ult from its browsing by goats.

The whitetail deer has often been the subject of experiments in nestication. The beauty of these animals, especially the fawns, peals to every admirer of wild life, and early settlers of the coun- r soon learned how easily they could be tamed and how promptly ey attached themselves to the persons who fed them. The danger- s character of the same pets, especially the males, when grown up as soon learned also. It followed that the domesticating process ually ended with the maturity of the first subject, which was soon sposed of or banished to a safe inclosure.

The propagation of the Virginia deer has seldom been undertaken a systematic way. The animals have often been bred in parks for easure or in large preserves for sport, but the economic possibili- s in raising them have received little attention. Recently breeders ive recognized the fact that they are profitable under proper man- gement and would be much more so were conditions for marketing ve animals and venison more favorable.

EXPERIENCES OF BREEDERS.

The Biological Survey has reports of successful experience in rais- ig Virginia deer from more than a dozen persons, located in differ- it parts of the country, who are now engaged in the business. The ianagement of the herds varies slightly with the surroundings and ie object for which they are kept.

Thomas Blagden, of Washington, D. C., began raising deer in 874. After an experience of over a third of a century he is confi- ent that the business can be made profitable. In his own herds he ias carefully avoided in-breeding by securing new bucks from time o time. His stock is vigorous and of the large size characteristic of he Adirondack and other northern deer. Consequently the animals ire in demand for breeding purposes, the bucks bringing $50 each ind the does $75. He feeds grain, using corn and a mixture of bran nd meal, and during the summer cuts as much wild forage as pos- ible. He finds that the animals prefer the rankest weeds to the hoicest grass. Of the various kinds of hay, they prefer alfalfa. He provides abundant water at all times.

John W. Griggs, of Goodell, Iowa, writes that he has been engaged in raising deer for about fourteen years. Until two years ago he sold all his surplus stock for parks, but since then has disposed of about half of it for venison. For park purposes he gets $20 to $30 a head, but they bring fully as much or more when fattened for venison. As to management of deer, Mr. Griggs writes:

> In raising a large herd the park should be divided into two or three lots, and one plowed each year and sown to red clover, mustard, rape, and seeds of different kinds of weeds. Bluegrass and timothy are useless. Corn is the

principal grain I feed. I feed it winter and summer. In winter I feed also clover hay, oat straw, and weedy wild hay. Deer when rightly handled are very prolific, and from 50 does one can count on 75 fawns. They can be raised profitably for venison—very profitably until overdone; but I would not advise one to go into it on a large scale without previous experience with deer.

The report received from C. H. Roseberry, of Stella, Mo., although less enthusiastic than others, is quoted because his herd approaches more nearly a state of true domestication. Under the date of January 13, 1908, Mr. Roseberry wrote as follows:

> My experience in breeding the common or Virginia deer covers a period of seventeen years, beginning in March, 1891, when, as a boy of 16, I built a small inclosure of 1½ acres to confine a single doe that was captured as a fawn in the neighboring forest.
>
> A buck and other does were secured from year to year, until in 1900, by purchase and natural increase, my herd numbered 25 head of all ages.
>
> From 1891 to 1901 I lost every year from disease an average of 20 per cent. The climax came in the drought year of 1901, when my loss was 50 per cent from the disease known as "black tongue."
>
> I am convinced that, like cholera in swine, individuals recovering from the disease are immune from further attack. Apparently all of my herd were afflicted. The survivors and their progeny constitute my present breeding stock. I have made no purchases since 1901, nor have I suffered any loss from disease.
>
> For the last seven years my herd has averaged 70 per cent increase, all of which I have sold at satisfactory prices. I began selling at $20 per pair of fawns at 4 months of age and $30 per pair of adults. I now get $40 and $[illegible] respectively. I sell almost exclusively for pets and for propagating purposes, although a few surplus bucks have been sold for venison, averaging [illegible] cents per pound gross weight.
>
> If we except the goat, I know of no domestic animal common to the farm that requires so little feed and attention as the deer. My herd has a range of only 15 acres, two-thirds of which are set to white clover, bluegrass, and orchard grass. I provide also a small plat of wheat or rye for winter pasture. With the above provision, in this latitude, no feed is required between April 15 and November 15. During the rest of the year a ration of corn, bran, or other mill feed somewhat smaller than that required for sheep, in connection with a stack of clover or pea hay to which they have free access, is sufficient to keep them in good condition. Deer eat with relish nearly all of the common coarse weeds, and for clearing land of brush they are, I think, second only to the common goat.
>
> Probably the greatest expense connected with the business of raising deer is the fencing. Another item of trouble and expense, when the animals are raised for pets, requiring that they be handled and shipped alive, is the fact that the fawns must be taken from the does when 10 days old and raised by hand on cow's milk. They are quite easily raised in this way, with but slight percentage of loss, but require frequent and careful attention for the first month. When they are allowed to run with the does their natural wildness can not be overcome, no matter how gentle the does may be.
>
> I have found the business profitable on the lines indicated. I believe they could be profitably bred for venison alone—certainly with less trouble and expense, since the fawns would be reared by the does and the trouble and expense of raising by hand would be eliminated.

My experience does not coincide with that of some other breeders[a] in respect to the weakening of reproductive powers of deer by the confinement in parks. I have no barren does. Usually they produce a single fawn at two years of age; afterwards twins, and in rare cases triplets.

MANAGEMENT OF VIRGINIA DEER.

As to the management of deer little need be added to the statements from practical breeders already given. Virginia deer are polygamous, like cattle; the rutting season is in November; the period of gestation is about seven months, and the fawns are born in May or June. Young does usually breed when about 17 months old and have but one fawn the first time; afterwards they commonly produce twins. The fawns are spotted until the first shedding of the hair in the fall.

While deer are chiefly browsing animals, in captivity they eat nearly every kind of vegetation, including most kinds of garden stuff. They are fond of acorns, beechnuts, chestnuts, and other mast. Lily pads, leaves, lichens, and mosses are freely eaten. With plenty of range and an abundant variety of plants there need be, therefore, no apprehension concerning the deer's food. A good supply of running water must be provided, and the animals should have access to rock salt. If the browse and pasturage are scant, a small ration of grain should be fed. Of the grains, corn is generally recommended as a food; there is no waste, as the deer pick up every grain. Coarse hay full of weeds is preferable to timothy or other tame hays, except alfalfa. Of clover hay, deer usually eat the blossom heads greedily, but waste the other parts. In winter feeding is necessary everywhere, and in the northern half of the United States shelter of some kind should be provided.

The remarks about castrating elk apply as well to the common deer. A number of vigorous bucks, however, must be kept with any considerable herd of does, for a single buck can not serve an unlimited number. Frequent changes of blood by introducing new bucks should be practiced to avoid inbreeding.

WILD DEER IN PRIVATE GAME PRESERVES.

Individual owners, as well as associations, have established large private preserves in many parts of the country and stocked them with deer and other big game. The objects have been to preserve the animals and to provide sport for the owners. In the free life under the protected conditions generally provided, deer do remarkably well, the increase being even more rapid than in small parks. There can be no doubt of the success of ventures in propagating the Virginia deer under natural conditions as wild game, as is proved by the experience of a large number of hunting clubs and private owners.

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[a] See Antelope and Deer of North America, by J. D. Caton, p. 304. 1877.

Deer in Buckwood Park, a New Jersey preserve of 4,000 acres belonging to Charles S. Worthington, increased in the ten years between 1892 and 1903 from 19 to about 400 head, and the number was then lessened because it was thought too large for the permanent sustaining capacity of the park. The St. Louis Park and Agricultural Company have about 1,000 deer and 400 elk in their 5,000-acre preserve in Taney County, Mo. The Otzinachson Rod and Gun Club six years ago placed about 90 deer, mostly does, in their 4,000-acre park in Clinton County, Pa. These have multiplied to nearly 2,000 head, and a further increase of about a thousand fawns is expected during the present season (1908). Doubtless these experiences are not exceptional.

The good effect of such preserves on the supply of game in the State should not be overlooked. While they may temporarily restrict the hunting privileges of a few citizens, they ultimately become a source of game supply secondary in importance only to State preserves or game refuges. Already a number of private reserves have become overstocked, and game has escaped or been turned over to the State to become the property of the people. The success of private enterprise in propagating large game in inclosures has thus become an object lesson for State game commissioners and others and suggests the feasibility of the State's undertaking a similar work for the people.

GAME LAWS IN RELATION TO DEER FARMING.

The chief obstacle to profitable propagation of deer in the United States is the restrictive character of State laws governing the killing, sale, and transportation of game. Many of the States, following precedent, lay down the broad rule that all the game animals in the State, whether resident or migratory, are the property of the State. A few States except game animals that are "under private ownership legally acquired." A few others encourage private ownership by providing a way in which wild animals—deer and the like—may be captured for domestication. Generally, when private ownership of game is recognized by law, the right to kill such game is granted, but the owner is hampered by the same regulations as to season, sale, and shipment that apply to wild game. One by one, however, State legislatures are coming to recognize the interests of game propagators, and game laws are gradually being modified in accordance with the change of view.

The chief source from which deer and elk may be obtained for stocking preserves is from animals already in captivity. These must be transported from place to place or there can be no commerce in them, yet the laws of many States absolutely forbid their shipment. The laws as to possession and transportation of deer carcasses make the shipping of venison also illegal. General export of venison is legal from only six of the States, and three of these have no wild deer left to protect.

The laws concerning the season for killing and the sale of deer are often equally embarrassing to those who would produce venison for profit. The owner of domesticated deer can not legally kill his animals except in open season. Owners of private preserves are similarly restricted and are limited to the killing of one or two animals in a season. More than half the States and Territories absolutely forbid the sale of venison. A few forbid the sale of venison produced within the State, but permit the sale of that imported from other States, a most unjust discrimination against home industry.

The following States have recently modified their laws so as to provide, under regulations, for the sale of deer from private preserves. Transportation and even export are included in some of them.

Arkansas.—Possession, sale, and shipment of deer or fawns is permitted when they have been raised in captivity for domestic purposes and are accompanied by an affidavit from the raiser.

Colorado.—Owners of private preserves under a license are permitted to sell and ship deer or other quadrupeds that are accompanied by an invoice. A fee is required for each animal sold.

Illinois.—Any person who raises deer for market may kill and sell them at any time in the same manner as other domestic animals.

Indiana.—The provisions of the law as to possession and sale do not apply to persons who have under ownership or control any deer raised in a deer park.

Massachusetts.—The owner may sell his own tame deer kept on his own grounds.

Minnesota.—Persons who desire to domesticate deer, moose, elk, or caribou may secure a permit to do so from the State board of game and fish commissioners by paying a fee of 50 cents for each animal in captivity and a like fee for each animal added later by natural increase or otherwise. The animals kept in captivity may be sold or shipped within or without the State, by permission of the commissioners.

Missouri.—Deer or elk, alive or dead, may be shipped from any private preserve and sold in the markets of the State when accompanied by a tag furnished by the game warden of the county, showing whose property it is, where killed, and to whom shipped.

New Hampshire.—The Blue Mountain Forest Association may kill elk, deer, or moose in their preserve for one month after the open season, and at any time may transport them outside the State.

New York.—Deer may be sold during the open season; and mo elk, caribou, and antelope from private parks may be sold dur the same period. Common carriers may transport animals into t State for breeding purposes, but may not transport venison unle is accompanied by the owner.

North Carolina.—Seventeen counties permit the owner and keep of an inclosed game reserve, who raises deer for use or sale, to k sell, or use those raised or kept in said inclosure.

Pennsylvania.—Owners of game preserves who hold a game-pro gating certificate may sell and transport deer or fawn alive f propagating purposes only, after securing the written consent of president of the board of game commissioners.

In three or four other States game "under private owner legally acquired," is supposed to be exempt from the general pro sions of the game law; but in a test case as to its sale or export it doubtful whether the courts would so hold without more specific p vision legalizing such commerce.

SUMMARY.

The domestication of deer and elk offers an interesting field experiment, as well as remunerative returns for the investment capital.

The wapiti and the Virginia deer can be raised successfully a cheaply under many different conditions of food and climate. T production of venison and the rearing of both species for stock parks may be made profitable industries in the United States.

Instead of hampering breeders by restrictions, as at present, S laws should be so modified as to encourage the raising of deer, and other animals as a source of profit to the individual and to State.

Safeguards against the destruction and sale of wild deer in p of domesticated deer are not difficult to enforce. For this p pose a system of licensing private parks, and of tagging deer carcasses sold or shipped, so that they may be easily ident is recommended.

It is believed that with favorable legislation much otherwise w land in the United States may be utilized for the production of v son so as to yield profitable returns, and also that this excellent nutritious meat, instead of being denied to 99 per cent of the p lation of the country, may become as common and as cheap in markets as mutton.

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